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The publications of the National Museum consist of two series: Proceedings and Bulletins.

The Proceedings, the first volume of which was issued in 1878, are intended primarily as a medium of publication for newly acquired facts in biology, anthropology, and geology, descriptions of new forms of animals and plants acquired by the National Museum, discussions of nomenclature, etc. A volume is issued annually or oftener for distribution to libraries, while in view of the importance to science of the prompt publication of descriptions of new species, a limited edition of each paper is printed in pamphlet form in advance.

The present volume is the twenty-sixth of the series.

The Bulletin, publication of which was begun in 1875, is a series of more elaborate papers, issued separately and based for the most part upon collections in the National Museum. They are monographic in scope, and are devoted principally to the discussion of large zoological groups, bibliographies of eminent naturalists, reports of expeditions, etc.

A quarto form of the Bulletin, known as the "Special Bulletin," has been adopted in a few instances in which a larger page was deemed indispensable.

The Annual Report of the National Museum (being the second volume of the Smithsonian Report) contains papers chiefly of an ethnological character, describing collections in the National Museum.

Papers intended for publication by the National Museum are usually referred to an advisory committee, composed as follows: Frederick W. True (chairman), William H. Holmes, George P. Merrill, James E. Benedict, Otis T. Mason, Leonhard Stejneger, Lester F. Ward, and Marcus Benjamin (editor).

S. P. Langley,
Secretary of the Smithsonian Institution.

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A REVIEW OF THE BERYCOID FISHES OF JAPAN.

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The present paper contains a review of the species of Berycidæ and related families, found in the waters of Japan. It is based on material collected by Jordan and Snyder in the summer of 1900, and on material in the United States National Museum, largely collected by the United States Fish Commission steamer *Albatross* in 1900.

The Berycoid fishes, as a whole, may be characterized by the presence of thoracic ventral fins, each with one spine and usually seven soft rays; head usually with conspicuous mucous cavities; air bladder in some species (*Beryx*, *Holocentrus*) retaining its duct through life, in others (*Trachichthys*, *Polymixia*) losing it with age; vertebræ in species examined 24 to 30; shoulder girdle and pharyngeals normal, the post-temporal not fused with the cranium; no suborbital stay. The Beryces, as thus characterized, form a natural group among the Percomorphi, allied to Percoidei and Scombroidei, but marked as a whole by the occasional retention of the archaic characters of the persistent air duct and the increased number of ventral rays, both characters derived from the Haplomi, their immediate ancestors and predecessors in the rocks as fossils. The group is a very old one in geologic time, older than any of the other Acanthopteri, the allies of *Beryx*, being among the earliest spiny-rayed fishes known. In the deep-sea forms the spinous dorsal is scarcely developed, and the scales are usually either cycloid or wanting. In the species of tropical shores the spinous armature of fins and scales is better developed than in most of the percomorphous fishes. All, except *Aphredoderus*, are marine fishes, inhabiting the tropical shores or the abysses of the ocean. The pertinence of Polymixiidæ to this group has been questioned, but according to Boulenger its skeleton is essentially Berycoid, although its curious barbels are almost exactly like those of *Mullus* and *Upeneus*.

We remove the Zeidæ from the Berycoids, although having similar ventrals, because no other distinct likeness appears, and the post-temporal is attached to the skull as in the Chætodonts. The Monocentridæ

are doubtless modified Berycoids, and we leave them in association, although recognizing no very close affinities. According to Boulenger, the Pempheridæ, with the Bathyclupeidæ, are near allies of the Berycoids, although having the ventral rays I, 5. Boulenger also places *Aphredoderus* among the Berycoid fishes with apparent justice. He further relegates *Stephanoberyx* and *Malacosarcus* to the Haplomi, an arrangement which may be open to question.

FAMILIES OF BERYCOIDEI.

a. Ventral rays I, 6 to 1, 10, usually I, 7.
  b. Chin without barbels; branchiostegals mostly 8.
    c. Dorsal fin single, with 2 to 8 spines; anal spines 1 to 4.
      d. Anal fin, with 4 spines its base, much long r than the dorsal base; suborbitals narrow; scales firm; ventral rays mostly I, 10 ..... BERYCIDÆ, I.
      dd. Anal fin relatively short, shorter than the dorsal; anal spines 1 or 2; ventral rays mostly I, 6, scales various; suborbitals usually broad, TRACHICHTHYIDÆ, II.
    cc. Dorsal fin deeply notched, with 10 to 13 strong spines; anal spines 4; scales firm, very rough .... HOLOCENTRIDÆ, III.
  bb. Chin with 2 long barbels attached just behind symphysis of lower jaw; branchiostegals 4; dorsal fin continuous, with 5 spines; anal spines 3 or 4; scales moderate ctenoid; body deep, compressed; vertebræ 29, POLYMIXIIDÆ, IV.
aa. Ventral rays I, 3, the spine very large; dorsal spines isolated, the anterior very strong; body covered with a coat of mail formed of rough scales, MONOCENTRIDÆ, V.

Family I. BERYCIDÆ.

Body oblong or ovate, compressed, covered with ctenoid, or cycloid, foliate, or granular scales. Head with large muciferous cavities, covered by thin skin. Eyes lateral, usually large. Nostrils, two on either side. Mouth wide, oblique. Premaxillaries protractile; maxillary rather large, usually with a supplemental bone. Suborbitals narrow, not sheathing the cheeks. Bands of villiform teeth on jaws, and usually on vomer and palatines; no canines; no suborbital stay. Opercular bones usually spinous. Branchiostegals 7 or 8. Gill-membranes separate, free from the isthmus. Gills 4, a slit behind the fourth. Pseudobranchiæ present; lower pharyngeals separate. Gill-rakers moderate. Cheeks and opercles scaly. No barbels. Dorsal fin continuous, with 2 to 8 weak spines; anal with 4 spines and many soft rays, much longer than the dorsal; ventral fins thoracic, mostly I, 7, the number of rays usually I, 10, always greater than I, 5; caudal fin usually forked. Pyloric cœca numerous. Vertebræ 24. Fishes mostly of the deep seas; the general color red or black. This group is an ancient type, a great number of extinct species being now known, from the Upper Cretaceous and later rocks. The following skeletal characters are added by Boulenger, these applying also to the Trachich-

thyidæ and Holocentridæ. One or more of suborbital bones, with an internal lamina supporting the globe of the eye. Anterior vertebræ without transverse processes; all or most of the ribs inserted on the transverse processes, where these are developed.

a. Scales ctenoid; teeth villiform on jaws, palatines, and vomer; vertebræ 24; muzzle short; chin projecting; preopercle spineless; opercles serrated; dorsal spines 4 to 7, graduated; anal rays IV, 26 to 30; ventrals I, 10................*Beryx*, 1.

1. BERYX[a] Cuvier.

Beryx Cuvier, Regne Anim., 2d ed., II, 1829, p. 151 (*decadactylus*).

Body deep, compressed, covered with rather large, ctenoid scales, which are regularly arranged. Abdomen trenchant, but without enlarged scutes. Head large, with thin bones and high ridges with deep muciferous cavities. Snout short, the mouth oblique, the chin prominent; eye large; both jaws, vomer, and palatines with villiform teeth. Opercles serrated, the opercle usually with spine; preopercle unarmed. Caudal forked; anal spines 4, soft rays 26 to 30; dorsal continuous, with 4 to 6 spines; ventrals with about 10 soft rays. Air bladder simple. Pyloric cæca numerous. Deep-sea fishes, beautifully colored, chiefly scarlet.

(*βέρυξ*, *Beryx*, a Greek name of some fish, taken by Gesner from Varinus.)

a. Scales in lateral line 64 to 65; D. IV, 16 to 19 ....*decadactylus*, 1.
aa. Scales in lateral line 71 to 76; D. IV, 13 to 15 ....*splendens*, 2.

1. BERYX DECADACTYLUS Cuvier and Valenciennes.

Beryx decadactylus Cuvier and Valenciennes, Hist. Nat. Poiss., III, 1829, p. 222; Madeira or Portugal.—Poey, Synopsis, p. 297.—Goode and Bean, Oceanic Ichth., 1895, p. 175.—Steindachner and Döderlein, Fische Japans, I, 1883, p. 12; Tokyo.—Ishikawa, Prel. Cat., 1897, p. 58; Tokyo.—Jordan and Evermann, Fish N. and M. Amer., I, 1896, p. 844.—Steindachner, Ichth. Bericht., IV, p. 1, pl. I; Canary Islands.

Head, $2\frac{1}{2}$; depth, $2\frac{1}{2}$; D. IV, 16 to 20; A. III or IV, 27 to 30; P. II, 14 to 15; V. I, 9 to 10. Lateral line 10 to 11, 70 to 73 (60 to 65) without caudal scales 21 to 22. Body oblong, considerably compressed, its height greatest at the origin of the dorsal; scales sharply ctenoid, with a strong middle keel. The maxillary reaches almost to the orbit, eye very large, its upper limb impinging upon the upper profile of the head, and $2\frac{1}{2}$ in the length of the latter; operculum with an indistinct spine; the preorbital spine about one-third the eye; snout about

[a] According to Dr. Boulenger, the genus *Pempheris* should be placed with the Berycidæ. "*Beryx* and *Pempheris* agree so completely in structure, both external and internal, with the sole exception of the rays in the ventral fins (1, 5 in *Pempheris*) that I am inclined to doubt whether the difference between them should be regarded as greater than that between the former and *Trachichthys*."

two-fifths, and the inter orbital space somewhat more than half the eye. The base of the dorsal exceeds its height, the latter two-thirds the head; the insertion of the anal is approximately in the vertical from the teeth to the twelfth dorsal ray, and its middle is slightly behind the ultimate ray of the dorsal; the distance of the insertion of the pectoral to the snout is equal to the length of the base of the anal; the ventral is inserted under the axil of the pectoral, reaching the anal; caudal s rongly forked. Length, 37 cm. (about $14\frac{1}{2}$ inches). (Description after Günther, Steindachner, Goode, Bean, Döderlein.)

Deep seas; recorded from Portugal, Madeira, Japan, and Cuba. No Japanese specimens seen by us.

(*δέκα*, ten; *δάκτυλος*, finger.)

2. BERYX SPLENDENS Lowe.

KIMMEDAI (GOLDEN-EYE PERCH).

Beryx splendens Lowe, Proc. Zool. Soc. Lond., 1833, p. 142; Madeira.—Goode and Bean, Oceanic Ichth., 1895, p. 176.—Steindachner and Döderlein, Fische Japans, I, 1883, p. 12; Tokyo.—Jordan and Evermann, Fish N. and M. Amer., I, 1896, p. 844.—Jordan and Snyder, Check List, 1901, p. 62; Yokohama.

Head, 3; depth, $2\frac{3}{5}$; D. IV, 13; A. IV, 27 to 29; P. I, 16 to 17; V, 10 to 11. Scales 10-74-18, counted in the lateral line. Body elongate, compressed, and the deepest part forward; covered with moderate-sized scales, which are furnished with fine prickles, giving a somewhat rough touch. Head large, compressed, and many of the ridges or edges of the bones roughened or finely serrate; eye very large in front of the head above, $1\frac{1}{3}$ in the maxillary and $2\frac{2}{5}$ in the head; upper profile of the head slightly convex from the tip of the snout; snout very blunt; lower jaw produced; mouth very oblique, so that the tip of the snout is level with the middle of the eye; the nostrils close together on the snout in front of the eye; the posterior larger; the maxillary is expanded distally for a little more than half an eye diameter and does not reach to the margin of the eye behind; teeth of the jaws very fine and in bands; a short spine in front of the eye directed backward; symphysis with a slight knob below in front; snout a little less than half the eye and $1\frac{1}{2}$ in the interorbital space; interorbital space flat; gill-opening very large, the membrane free from the isthmus; gill-rakers long and slender, 6–16, the longest equal to half the eye. Dorsal spines weak, graduated to the fourth, which is the longest, though falling short of the first ray, which is the highest of the dorsal fin; the origin of the anal falls below the base of the posterior dorsal ray, the spines graduated to the third, which is the longest; soft anal highest at the first ray, then sloping down till about half as high, so that the posterior part of the fin is of uniform height; pectorals very long, equal to the base of the soft anal and

reaching the base of the third soft ray; ventrals a little in advance of the dorsal but behind the pectorals and a little shorter than the latter in length; caudal forked, the lobes pointed; caudal peduncle compressed, two-thirds to three-fourths the length of the eye; lateral line high, inclined concurrent with the back, and running out on the base of the caudal; the rudimentary caudal rays, 3 or 4 sharp graduated spines above and below.

Color in alcohol uniform pale; in life bright scarlet, silvery white below. This description from two specimens, length 10¾ inches, obtained by Mr. Otaki from outside the entrance to Tokyo Bay, where it is said to be not rare. Other specimens were obtained by Jouy near Yokohama. Form a little more slender than Atlantic specimens but otherwise similar. The species is known from Madeira and from the Gulf stream.

(*splendens*, shining.)

Family II. TRACHICHTHYIDÆ.

This family is composed of deep-sea Berycoids differing from the Berycidæ in the short anal, shorter than the dorsal and usually with 1 or 2 species. The dorsal is single, the ventral rays usually I, 6; the scales various, usually rough and deciduous; the belly compressed, with a serrated edge; suborbitals usually broad; vertebræ, 26 to 28; color blackish; size, rather small.

a. Trachichthyinæ.—Scales large, normally formed; teeth small.
- *b.* Vent normally placed, well behind the ventrals, the abdominal serræ before it.
  - *c.* Dorsal spines 7 or 8, strong, the median ones highest........*Gephyroberyx*, 2.
  - *cc.* Dorsal spines 6, slender, graduated. Vomer toothless; opercle entire; scales large ....*Hoplostethus*, 3.
- *bb.* Vent inserted well forward close behind the ventrals; the abdominal serræ behind it; vomer toothless..............................*Paratrachichthys*, 4.

2. GEPHYROBERYX Boulenger.

Gephyroberyx BOULENGER, Ann. Mag. Nat. Hist., March, 1902, p. 203 (*darwini*).

Body rather short, covered with large rough, irregular scales; ventral ridge serrated; snout short, rounded; mouth oblique; eye large; very fine teeth on jaws, vomer, and palatines. Vent far behind ventrals. Branchiostegals 8; a strong spine on the shoulder girdle; one on angle of preopercle; a small one on the opercle; suborbital with radiating ridges; dorsal single, with 7 or 8 spines, strong and wide apart, the middle ones highest; ventral rays I, 6; caudal forked. Fishes inhabiting considerable depths, known from Madeira, India, and Japan. The genus is allied to *Trachichthys*, differing in the stronger and more numerous dorsal species.

(γεφύρος, bridge: Beryx.)

3. GEPHYROBERYX JAPONICUS (Döderlein).

Trachichthys japonicus Döderlein, Fische Japans, I, 1883, p. 10; Tokyo.

Head $2\frac{1}{2}$; depth $2\frac{1}{5}$. D. VII, 15; A. III, 12; P. I, 14; V. I, 6; pores in the lateral line 30; abdominal serræ 14.

Body deep and compressed, and covered with small, rough ctenoid scales; the scales containing the pores of the lateral line a trifle enlarged, and the scales on the front of the back very small. Head very deep and compressed, the ridges of the bones somewhat elevated and forming mucous cavities, over which are thin covering membranes; upper profile slightly convex, or nearly straight with the snout very obtusely rounded; eye small, its posterior margin a little nearer the gill-opening than the tip of the snout $3\frac{1}{5}$ in the head, a little over 2 in the maxillary, and equal to the interorbital space; mouth very oblique, the maxillary extending to below the posterior part of the eye; nostrils large, the posterior the larger, directly in front of the anterior margin of the eye above, and the anterior about half an eye diameter distant; jaws rough, and with a single series of small firm teeth along the edges; the lower jaw projects and the symphysis is somewhat knobbed, so that it protrudes a little in front; vomerine teeth small; at the origin of the lateral line at the back part of the head above a sharp spine, another on the posterior margin of the opercle above, still another in front of the base of the pectoral, and one at the lower part of the preoperculum, the latter strong, long, and sharp; two small, short spines at the front of the snout; operculum strongly striate; interorbital space convex; gill-opening large; gill-rakers long, slender, pointed, seven-sixteenths; branchiostegals 8; gill-membrane free over the isthmus. The dorsal fin begins a short distance behind the gill-opening, the spinous part highest in the middle, then descending to the soft dorsal, which is also higher in front; first anal spines short, the third the longest; soft anal high in front, sloping behind; pectoral long, $1\frac{3}{5}$ in the head; ventrals short, not reaching the origin of the anal by half their length; caudal deeply emarginate, the lobes pointed; rudimentary caudal rays developed as 6 spines above and below. Lateral line inclined from the upper part of the head to the base of the caudal; caudal peduncle three-fourths of the eye; vent far behind ventrals, space from between the ventrals to the anus with a single series of bony scutes or serræ.

Color in alcohol, brown, the fins pale, the inside of the mouth blackish, and the peritoneum black. Length $4\frac{5}{16}$ inches. Here described from an example dredged by the United States Fish Commission steamer *Albatross* in Suruga Bay at Station 3716. The species is otherwise known only from the description given by Dr. Döderlein of specimens from Tokyo, probably taken in Sagami Bay. Dr. Boulen-

ger speaks of the occurrence of *Gephyroberyx darwini* Lowe (from Madeira) in Japan. He has doubtless reference to *Gephyroberyx japonicus* a species which needs comparison with *G. darwini*, from which it differs, perhaps, in the presence of 7 instead of 8 dorsal spines.

3. HOPLOSTETHUS Cuvier and Valenciennes.

Hoplostethus Cuvier and Valenciennes, Hist. Nat. Poiss., IV, 1829, p. 469 (*mediterraneus*).

Body short and deep, much compressed. Head short, compressed, very blunt anteriorly, deeper than long, with very conspicuous mucous cavities. Eye very large. Mouth very oblique, the jaws equal when the mouth is closed. Maxillary long, broad behind, with a distinct supplemental bone, which reaches the posterior border of the eye. Teeth very fine, villiform, on jaws and palatines, none on the vomer. Suborbital with radiating ridges and a few spines; a vertical ridge on the front of the opercle. Opercle little developed, its spine small or obsolete; a strong spine at the angle of the preopercle; the long vertical limb of the preopercle finely serrated. Gill-membranes separate, free from the isthmus. Branchiostegals 8. Scales moderate or small, ctenoid; lateral line present, its scales enlarged; abdomen with a series of bony plates, each ending in a retrose spine. Dorsal fin continuous, short, the spines graduated, 6 in number; anal with 3 graduated spines; caudal forked, its rudimentary rays spinous; pectorals low, rather long; ventrals I, 6, rather short. Air bladder simple. Pyloric cœca numerous. Vertebræ 11 + 15. Deep-sea fishes, red in color.

Boulenger, following Lowe, unites *Hoplostethus* with *Trachichthys*. The difference is certainly slight, *Hoplostethus* lacking vomerine teeth and having 6 dorsal spines instead of 3.

(ὅπλον, armor; στῆθος, breast.)

4. HOPLOSTETHUS MEDITERRANEUS Cuvier and Valenciennes.

HINCHIDAI (FLINT-PERCH).

Hoplostethus mediterraneus Cuvier and Valenciennes, Hist. Nat. Poiss., IV, 1829, p. 469; Mediterranean Sea.—Günther, Cat., I, 1859, p. 9.—Jordan and Gilbert, Synopsis, 1883, p. 458.—Goode and Bean, Oceanic Ichthyology, 1895, p. 181.—Ishikawa, Prel. Cat., 1897, p. 58; Kii.

Trachichthys pretiosus Lowe, Proc. Zool. Soc. Lond., 1839, p. 77; Madeira.

Hoplostethus japonicus Hilgendorf, Sitz. Ges. Naturforschende Freunde, Berlin, 1879, p. 78; Japan.

Hoplostethus mediterraneus (var. ?) Steindachner, Fische Japans, I, 1883, p. 10, pl. I; Tokyo.

Head, $2\frac{3}{5}$ to $2\frac{2}{3}$; depth, 2 to $2\frac{1}{5}$; D., VI, 13 to 14; A., III, 9 to 10; P., I, 14 to 16; V., I, 6; ventral scutes, 9 to 15; scales, 28 to 29. Body ovate, deep, compressed, and covered with small ctenoid scales, except those of the lateral line, which are enlarged; above and on the

back in front the scales are exceedingly small. Head very large and deep, the ridges of the bones elevated and forming large mucous cavities between covered with thin transparent membranes; upper profile roundly convex from the snout; eye very large, in the upper half of the head, its posterior margin nearer the gill-opening than the tip of the snout, 3 in the head, 2 in the maxillary, and a little more than the width of the interorbital space; mouth oblique, the maxillary extending till a short distance from the posterior margin of the eye; nostrils large and directly in front of the upper part of the eye, like most of the exposed ridges of the head roughened; the lower jaw projecting and with a small protruding process at the symphysis; above the operculum, at the origin of the lateral line a strong spine, and another at the end of the preoperculum below, the latter very broad; 3 bony ridges cross over from the eye to the preoperculum; teeth small, fine, and in broad bands in the jaws, forming a series slightly enlarged inside; no vomerine teeth; interorbital space high and convexly rounded; opercles with many striæ; gill-openings very large; gill-rakers 6+16, very long and slender, much larger than the gill-filaments; branchiostegals 8; gill-membrane free from the isthmus; dorsal a short distance behind the gill-opening; the spinous fin graduated to the last spine, which is as long as the eye, but not as high as the anterior soft dorsal rays, which are the highest part of that fin, and rounded; anal spines with the first 2 very short, and the third very long, though not equal to the longest anal rays; pectoral very long, shorter than the head, and reaching the origin of the soft anal; ventrals short, about 1¾ in the head, and not reaching the anus; caudal deeply emarginate and with the lobes somewhat pointed; rudimentary caudal rays developed as 6 graduated spines above and below. The lateral line a series of large pores obliquely from the upper part of the head to the base of the caudal. Space from between the ventrals to the anus armed with a single series of backwardly directed serræ. Caudal peduncle compressed and about equal to the eye.

Color in alcohol brown, the fins pale, the inside of the mouth and the peritoneum black. Total length, 9⅝ inches. Here described from specimens dredged in Sagami Bay by the U. S. Fish Commission steamer *Albatross*.

In young examples the ventrals reach the anus, the pectorals are longer, the preopercular spine is longer, and in the smallest examples, from Kishyu, the sides are scaly like the rest of the body. All the specimens have the single bony bridge across the preoperculum from one margin to the other at about one-fourth its height.

Coasts of Japan in deep water; our specimens dredged in deep water by the U. S. Fish Commission steamer *Albatross* in Sagami Bay, at stations 2339 and 2348 and at stations 3721 and 3738 in Suruga Bay. We also have a small specimen from Kishyu (Kii).

We are wholly unable to find any difference between our specimens and the accounts given of the Mediterranean species, which is also well diffused in the deep waters of the Atlantic.

4. PARATRACHICHTHYS Waite.

Paratrachichthys WAITE, Scient. Results, H. M. C. S. Thetis, 1899, p. 64 (*traillii*).

This genus is allied to *Gephyroberyx*, differing in the anterior insertion of the vent, which is close behind the ventral fins; a series of bony serræ behind the vent. Scales small, rough—ctenoid; no vomerine teeth; dorsal spines 6, graduated. Japan to Australia, in deep water. (παρά, near: *Trachichthys*.)

5. PARATRACHICHTHYS PROSTHEMIUS Jordan and Fowler, new species.

Head, $2\frac{5}{6}$; depth, $2\frac{2}{3}$; D. VI, 14; A. III, 9; P. I, 11; V. I, 6; ventral scutes, 9; scales, 54. Body elongate, compressed, and covered

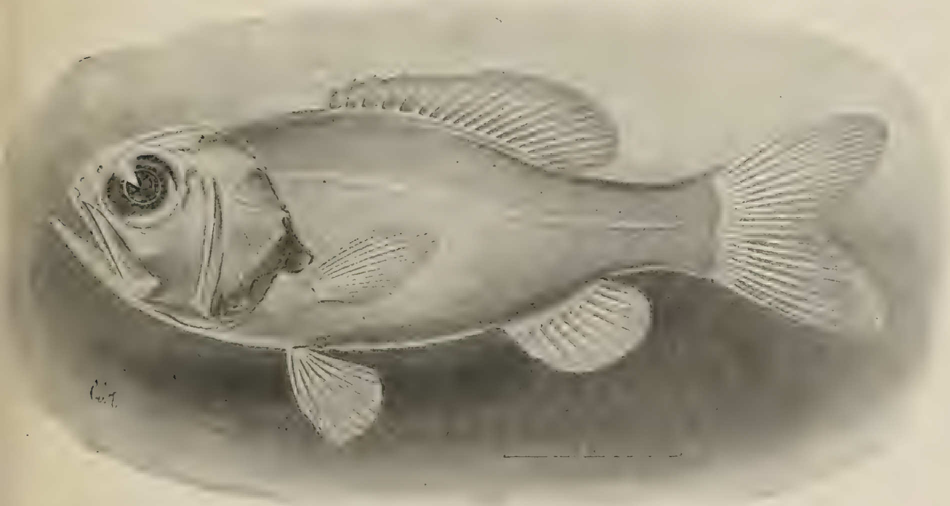

FIG. 1.—PARATRACHICHTHYS PROSTHEMIUS.

with small, rough, ctenoid scales, those of the lateral line not especially enlarged; above, on the front part of the back, the scales are very small. Head large, deep, and compressed, the ridges of the bones somewhat elevated and forming mucous cavities between which are thin covering membranes; upper profile roundly convex, the snout very obtuse, eye large, its posterior margin nearer the tip of the snout than the posterior margin of the gill-opening, $2\frac{2}{3}$ in the head; $1\frac{1}{2}$ in the maxillary, and greater than the interorbital space; mouth very oblique, the maxillary extending nearly to the posterior margin of the eye; nostrils large and directly in front of the eye; above, teeth of the jaws very fine and in broad bands; no vomerine teeth; lower jaw projecting; most of the protruding ridges of the head roughened; above the operculum, at the origin of the lateral line a sharp spine directed back-

ward, another on the posterior margin of the opercle above, and still another at the end of the preoperculum below; there are no distinct bony ridges connecting the eye with the anterior edge of the preoperculum, and the latter is parallel with its posterior edge but not crossed by a bony bridge; interorbital space flatly convex; opercles with many striæ; gill-opening very large; gill-rakers 6–15, very long and slender, much longer than the longest gill-filaments; branchiostegals, 8; gill-membrane free from the isthmus. Dorsal a short distance behind the gill-opening, graduated to the last spine, which is the longest and nearly equal to the eye; soft dorsal high in front and then sloping behind; anal graduated to the third and longest spine, which is not equal to the higher soft rays; pectoral small, $1\frac{2}{3}$ in the head, and reaching beyond the ventrals; ventrals short, about $1\frac{2}{3}$ in the space between their own origin and the origin of the anal; caudal emarginate and the lobes pointed; rudimentary caudal rays devoloped as 6 graduated spines above and below. The lateral line obliquely running from the upper part of the head to the base of the caudal. Caudal peduncle compressed, $2\frac{2}{3}$ in the head. Space from between the ventrals nearly to the origin of the anal provided with a single series of backwardly directed serræ. Vent in front of the abdominal serræ and between the ventrals.

Color in alcohol brown, the fins all pale, blackish between the mandibles and over the branchiostegal membranes; peritoneum black and some parts of the mouth blackish inside. Length, $2\frac{7}{16}$ inches. Here described from a specimen dredged at station 3730 by the U. S. Fish Commission steamer *Albatross* in Suruga Bay.

It is numbered 50575, U.S.N.M.

(*προσεμιός*, forward, in allusion to the location of the vent.)

FAMILY III. HOLOCENTRIDÆ.

SOLDIER-FISHES.

Body oblong or ovate, moderately compressed, covered with very strongly ctenoid or spinous scales. Head with large muciferous cavities, eye lateral, very large; preorbital very narrow; mouth moderate, oblique; premaxillaries protractile; maxillary very large, with supplemental bone; bands of villiform teeth on jaws, vomer, and palatines. Opercular bones and membrane bones of head generally serrated or spinescent along their edges. Branchiostegals 8. Gill-membranes separate, free from isthmus. Gills 4, a slit behind fourth. Pseudobranchiæ present. Gill-rakers moderate; no barbels. Sides of head scaly. Lateral line present. Dorsal fin very long, deeply divided, with about 11 strong spines depressible in a scaly groove; anal with 4 spines, the third longest and strongest; ventrals thoracic, with 1 spine and 7 rays; caudal deeply forked, with sharp rudimentary rays or

fulcra at base. Vertebræ about 27. Pyloric cœca 8 to 25. Air bladder large, sometimes connected with the organ of hearing. General color red. Young with the snout sharp and produced (constituting the nominal genera *Rhynchichthys*, *Rhamphoberyx*, and *Rhinoberyx*, based on peculiarities of immature examples). Skeletal characters essentially in *Beryx*, the fin spines much stronger. Gaily colored inhabitants of the tropical seas, abounding about coral reefs.

a. Preopercle without conspicuous spine at its angle; scales very large (about 28) and very rough .... *Ostichthys*, 5.
aa. Preopercle with a conspicuous spine; suborbital arch simply serrated; scales moderate, 38 to 55; mouth moderate .... *Holocentrus*, 6.

5. OSTICHTHYS Jordan and Evermann.

Ostichthys (Langsdorff Ms.) Cuvier and Valenciennes, Hist. Nat. Poiss., III, 1829, p. 174 (*japonicus;* name only, passing reference).
Ostichthys Jordan and Evermann, Fishes N. and M. Am., I, 1896, p. 846 (*japonicus*).

This genus is closely related to *Holocentrus*, differing externally, in the absence of the large spine at the angle of the preopercle and especially in the very rough surface of the large scales. In this regard it differs from *Myripristis*, which, while lacking also the preopercular spine, has the scales of *Holocentrus*. *Holotrachys* (*lima*), another genus with similarly rough scales, differs from *Ostichthys* in having the scales very much smaller, about 45 in the lateral line instead of 28, as in *Ostichthys*.

(ὀστέον, bone; ἰχθύς, fish.)

6. OSTICHTHYS JAPONICUS (Cuvier and Valenciennes).

KINDAI (GOLDEN PERCH); NISHIKIDAI (BROCADE PERCH); UMIKINUWO (SEA GOLD-FISH).

Myripristis japonicus Cuvier and Valenciennes, Hist. Nat. Poiss., III, 1829, p. 173, pl. LVIII; Japan Coll. Langsdorff.—Schlegel, Fauna Japonica, Poiss., 1847, p. 23, pl. IX a; Nagasaki.—Günther, Cat. Fish., I, 1859, p. 25; Japan, China, Ile de France.—Steindachner, Fische Japans, I, 1883, p. 14; Tokyo.
Ostichthys japonicus Jordan and Evermann, Proc. U. S. Nat. Mus., XXV, 1902, p. 334; Formosa.

Head, $2\frac{3}{5}$; depth, $2\frac{1}{4}$; D. XII, 13; A. IV, 11; P. I, 16; V. I, 7. Scales, $\frac{4}{2}$–28–7. Body deep and compressed, covered with large scales which are provided with parallel striæ forming a prickly edge behind, and some of the middle ones sharp and strong. Head, large, the ridges of the bones large and striate; upper profile convex; eye, large, above and in front, $3\frac{1}{5}$ in the head, about $1\frac{1}{7}$ in the maxillary, and $2\frac{1}{2}$ in the height of the preoperculum; the mouth is very large, inclined, the maxillary expanded distally, so as to fall very little short of an eye diameter, and reaching posteriorly beyond the eye; jaws large and powerful, the upper scooped out in front so that the symphysis of the mandible

fits in; the lower jaw projects; teeth in small rough patches or bands in the jaws; nostrils close together, directly in front of the eye, and the posterior very large, 4 in the eye; lips thick, fleshy, and papillose; interorbital space $1\frac{2}{3}$ in the eye; very slightly elevated; opercle above with a strong, backwardly produced spine; 9 scales along the posterior edge of the preoperculum on the operculum cheeks sealed; gill-opening, very large, the membrane free from the isthmus; gill-rakers, 6, 11, very long, slender, pointed, and $1\frac{1}{2}$ in the eye. Dorsal inserted before the posterior edge of the gill-opening, third and fourth species longest and strongest, about $2\frac{1}{2}$ in the depth of the body; soft dorsal highest in front, nearly equal to the highest dorsal spines; the third anal spine the longest to the eye, the soft part of the spine nearly as

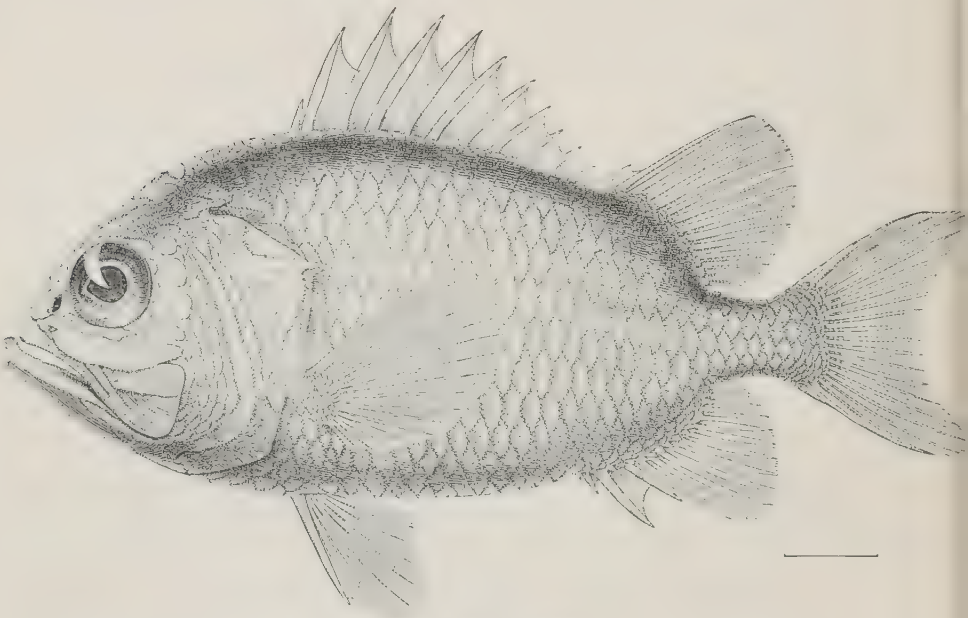

Fig. 2.—Ostichthys japonicus.

high as the soft dorsal; pectorals low, a little in front of the dorsal, not reaching the vent, and $1\frac{1}{2}$ in the head; ventrals below pectorals shorter, and the spines a trifle shorter than the fourth dorsal spine. Lateral line inclined to the base of the caudal from the upper part of the head. Caudal peduncle rather thick, compressed, and $1\frac{2}{3}$ in the ventral spine.

Color, in alcohol, pale; in life, bright crimson. Length, $13\frac{1}{4}$ inches. Here described from a specimen from Giran, Formosa.

Of this fine large fish we have examined a living specimen in the Asakusa Aquarium from Misaki, and another from Giran, Formosa. It is occasionally taken off the rocky headlands of Southern Japan, but it is nowhere common. Our figure is taken from the Giran specimen.

6. HOLOCENTRUS (Artedi) Scopoli.

Holocentrum Artedi, Seba, III, about 1738, nonbinomial (*rubrum*).
Holocentrus Gronow, Zoophyl, 1763, p. 65 (*rostratus*, nonbinomial).
Holocenthrus (Gronow) Scopoli, Int. Hist. Nat., 1777, p. 449 (misprint).
Holocentrus Bloch, Ichthyol., IV, 1790, p. 61 (*sogo*).
Rhynchichthys Cuvier and Valenciennes, Hist. Nat. Poiss., VII, 1831, p. 503 (*pelamidis;* young).
Rhinoberyx Gill, Proc. Acad. Nat. Sci. Phila., 1862, p. 237 (*brachyrhynchus;* young; scales said to be 25; may represent a distinct genus).
Holocentrum of authors generally.

Body oblong, moderately compressed, the ventral outline nearly straight, the back a little elevated, the tail very slender. Head compressed, narrowed forward. Operculum with a strong spine above, below which the edge is sharply serrated; a strong spine at the angle of preopercle. Orbital ring, preorbital, preopercle, interopercle, subopercle, occiput, and shoulder girdle with their edges sharply serrate. Mouth small, terminal, the maxillary not extending to the middle of eye; the lower jaw projecting in the adult; in the young (which constitute the supposed genera *Rhynchichthys* and *Rhinoberyx*) the snout is much produced. Maxillary broad, striate, with a supplemental bone. Eye excessively large. Scales moderate, closely imbricated, the posterior margin strongly spinous. Lateral line continuous. Dorsal deeply emarginate, the spines usually 11, depressible in a groove; soft dorsal short and high; anal with 4 spines, the first and second quite small, the third very long and strong, the fourth smaller; caudal widely forked; both lobes with the rudimentary rays spine-like; ventrals large, I, 7, the spine very strong. Species numerous, remarkable for the development of sharp spines almost everywhere on the surface of the body.

(ὅλος, whole; κέντρον, spine; spinous all over.)

a. Scales 36 to 37.
  b. Color red, striped with white; spinous dorsal plain............*spinosissimus*, 7.
  bb. Color red, striped with black; spinous dorsal with black blotches..*alboruber*, 8.
aa. Scales 48; color red, striped with darker; base of pectoral and tips of caudal black..*ittodai*, 9.

7. HOLOCENTRUS SPINOSISSIMUS Schlegel.

ITTODAI (NUMBER ONE PERCH).

Holocentrus spinosissimus Schlegel, Fauna Japonica, 1847, p. 22, pl. viii, A; Nagasaki.—Günther, Cat. Fish., I, 1859, p. 41 (copied).

Head, $2\frac{2}{3}$; depth, $2\frac{2}{3}$; D., XI, 13; A., IV, 9; P., I, 13; V., I, 7. Scales 3–37 or 38–6. Body rather long, compressed, and covered with large, striated scales, rather rough to the touch. Head compressed, and the upper profile somewhat convex; eye large, its posterior margin nearer the gill-opening than the tip of the snout, $2\frac{1}{4}$ in the head and equal

to the maxillary; snout bluntly pointed, 2 in the eye; nostrils directly in front of the eye, and the posterior very large; mouth inclined, the maxillary expanded distally till it is $2\frac{3}{5}$ in the eye, and reaching below the first two-thirds of the eye; teeth in fine, roughened bands in the jaws; the lips rather thick and fleshy; the lower jaw projects but little; interorbital space concave above and equal to about three-fifths the eye; bones on the head rough, striated, and with the edges serrated; two opercular spines; preoperculum with its lower angle with a strong backward spine; five rows of scales on the cheeks; preorbital spine strong; gill-opening large; gill-rakers 7+10, rather short and most of them poorly developed. Dorsal before the edge of the gill-opening and the pectoral, the third and fourth spines the highest; soft dorsal highest in front and nearly as high as the spinous dorsal; third anal

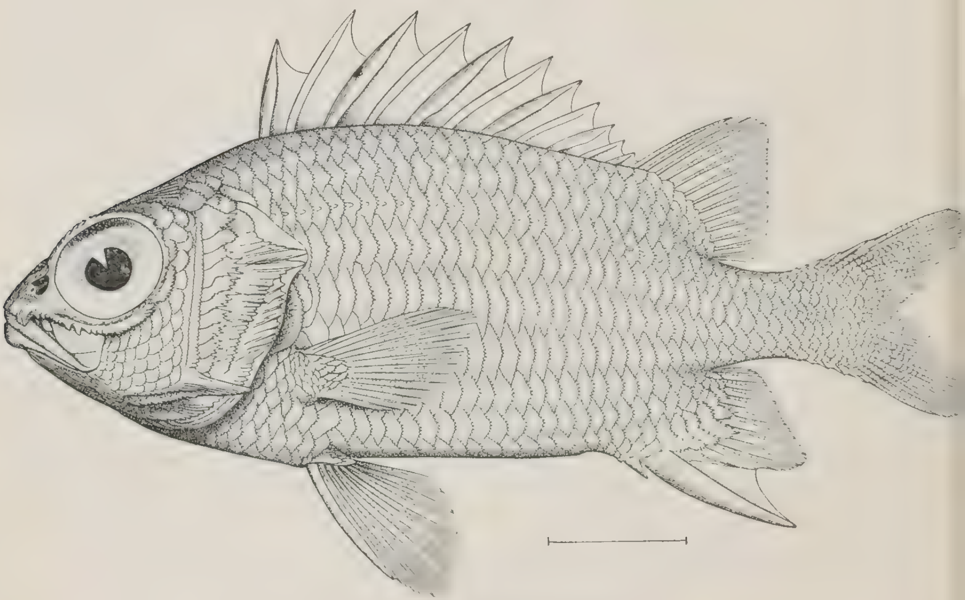

FIG. 3.—HOLOCENTRUS SPINOSISSIMUS.

spine very strong and long, though not as long as the longest rays, which are in front; pectoral a trifle shorter than the ventral, and about equal to the third anal spine; ventrals a little behind pectorals and with their tips reaching for nearly two-thirds the space between their bases and the origin of the anal; caudal emarginate, the lobes distinct; rudimentary caudal rays several and developed as graduated spines above and below; lateral lines inclosed from the head to the base of the caudal; caudal peduncle compressed, about two-thirds the eye.

Color plain brown in alcohol, with traces of 9 longitudinal silvery bands, and the cheeks and opercles silvery. Length 7 inches. Here described from two examples from Wakanoura.

Color in life brilliant scarlet, with white stripes, one stripe extending obliquely below the eye.

This beautifully colored fish is occasionally taken on rocky shores in the Kuro Shiwo, of southern Japan. Our specimens are from Wakanoura, where it is common in the open water.

(*spinosissimus*, most spiny.)

8. HOLOCENTRUS ALBORUBER Lacépède.

? *Sciæna rubra* FORSKÅL, Descr. Anim., 1775, p. 48; Red Sea.
? *Perca rubra* SCHNEIDER, Syst. Ichth., 1801, p. 90 (after Forskål).
? *Holocentrus ruber* RÜPPELL, Atl., 1828, p. 83, pl. XXII, fig. 1; Red Sea.
Holocentrum rubrum GÜNTHER, Cat. Fish., I, 1859, p. 35 (in part?); Amboina, Japan, Louisiades, Philippines, China, India, Red Sea.—BLEEKER, Atl. Ichth. IX, pl. III, fig. 4.
(*Holocentrum rubrum* DAY, Fishes India, pl. XLI, fig. 4, is apparently some other fish.)
Holocentrum rubrum ISHIKAWA, Prel. Cat., 1897, p. 58; Miyakoshima.
Holocentrum alborubrum LACÉPÈDE, Hist. Poiss., IV, 1803, p. 372; China Seas, from a Japanese print.—RICHARDSON, Ichth. China, 1846, p. 223; Canton.
? *Perca praslin* LACÉPÈDE, Hist. Poiss., IV, 1803, p. 418; New Britain.
? *Holocentrum orientale* CUVIER and VALENCIENNES, Hist. Poiss., III, 1829, p. 197; VII, p. 497; Red Sea, Pondicherry.
? *Holocentrum marginatum* CUVIER and VALENCIENNES, Hist. Poiss., III, 1829, p. 216; India.

Head, $2\frac{1}{5}$; depth, $2\frac{3}{5}$; D., XI, 13; A., IV, 10; P., I, 13; V., I, 7. Lateral line 3–36–7. Body elongate, compressed, and covered with rather large ctenoid scales. Head moderate, the upper profile strongly convex over the eyes; eye large, $2\frac{3}{5}$ in the head and impinging upon the upper profile; snout pointed, a little over half the eye; mouth terminal, inclined, the lower jaw slightly projects, and the maxillary does not reach the middle of the eye; teeth minute and in bands in the jaws; nostrils directly in front of the eye and the posterior very much the larger; cheeks with 4 rows of scales; interorbital space slightly concave; opercles with two strong spines; the preoperculum with a single strong spine below, and the preorbital spine short; head more or less striate, and with the edges of the bones more or less denticulate; gill-opening large; gill-rakers 6–10, slender, pointed, rather poorly developed. Dorsal about over the pectorals, the spinous fin rather high, highest in the middle and in front; soft dorsal about over the spinous anal, the anterior rays the highest, but not as high as the anterior rays of the soft anal, which are also the highest of that fin; third anal spine strong, long, and at least equal to the highest anal ray; pectorals shorter than the ventrals, about $1\frac{3}{5}$ in the head; ventrals behind the pectorals; the spine a little more than two-thirds the length of the fin, and its tip not reaching the vent; caudal forked, the lobes produced; rudimentary caudal rays as 4 graduated spines above and below. Lateral line nearly concurrent with the back to the base of the caudal; caudal peduncle compressed, about $1\frac{1}{4}$ in the eye.

Color in alcohol brown, dark and deep above, the sides with about

9 longitudinal broad bands following the course of the scales; dorsal light, with the membrane between the first 3 spines, with a broad blackish band above, which is continued on the membrane of the rest of the fin as a broad black blotch in front of each spine; membrane, including the fourth anal spine to the first soft ray, black; edge of the caudal above and below brownish; the head above is more or less uniform brownish; the lower surface of the body has a silvery appearance; membrane between the ventral spine and the first ray white.

In life the species was deep red with white longitudinal stripes.

Length about 5¾ inches. Here described from an example from Okinawa, Riukiu.

Of this strongly marked species we have one specimen from Nafa, in Okinawa. It agrees fairly with Günther's description of *Holocentrus ruber*, or rather with the Japanese, Louisiade and Amboina specimens, having the anal spine 5 in total length, not 4⅓, as in the Red Sea example, presumably typical of *H. ruber*. In Bleeker's figure the preopercular spine is represented as much longer than in our examples. Day's description and figure differ so much that we suppose them to belong to another species. In view of the uncertainty as to the identity of the Japanese form with *Holocentrus ruber* of the Red Sea, we retain provisionally the name *Holocentrus alboruber*, which seems to admit of no doubt. The species may however prove fully identical with *Holocentrus ruber*.

(*albus*, white; *ruber*, red.)

9. HOLOCENTRUS ITTODAI Jordan and Fowler, new species.

Head 3⅙; depth 2⅞; D., XI, 14; A., IV, 11; P., I, 13; V., I, 7. Lateral line 3–48–7. Body elongate, compressed, and covered with small, ctenoid scales. Head rather small, the upper profile strongly convex over the eyes; eye very large, 2½ in the head, and impinging upon the upper profile; snout pointed, about 2 in the eye; mouth small, inferior and inclined, the maxillary not reaching to the middle of the eye; teeth minute and in bands on the jaws; nostrils directly in front of the eye and the posterior very much the larger; interorbital space slightly concave, cheeks with 5 rows of scales; opercles with 2 strong spines; the preoperculum with a single strong spine below, and the preorbital spine short; head more or less striate and with the edges of the bones finally denticulate. Gill-opening large, the gill-rakers 5+11, slender, pointed, rather poorly developed. Dorsal about over the pectoral, the spinous fin rather high, highest in the middle; soft dorsal beginning over the origin of the spinous anal, the anterior rays the highest, but not as high as the anterior rays of the soft anal, which are also the highest of that fin; third anal spine strong, long, and equal to the highest soft ray; pectorals shorter than the ventrals, about 1½ in the head and about equal to the third anal spine; caudal

forked, the lobes produced; rudimentary caudal rays as 4 graduated spines above and below. Lateral line inclined to the base of the caudal; caudal peduncle compressed, about $1\frac{1}{2}$ in the eye.

Color red in life, in alcohol brown, the sides with 11 white longitudinal bands following the course of the scales; spinous dorsal with a narrow white longitudinal band running not far from the base of the fin, above which in front is a broad blackish band, distinct between the first 3 spines only.

Total length $4\frac{5}{8}$ inches. Here described from a specimen from Okinawa, Riukiu.

FIG. 4.—HOLOCENTRUS ITTODAI.

Of this species we have a single example from Nafa, in Okinawa. It is apparently nearest to *Holocentrus diadema*, but it is markedly different in color.

(*ittodai*, number one Tai or Porgy; *Itto*, meaning number one among many, (probably for its beauty.)

Family IV. POLYMIXIIDÆ.

BARBUDOS.

Body rather elongated and compressed; scales not serrated; lateral line continuous with back; head compressed, and with a decurved profile; preoperculum serrated; mouth with a lateral and nearly horizontal cleft; teeth villiform, on both jaws and on palate; branchiostegal apertures large, the gill-membranes separate, free from the isthmus; branchiostegals 4; dorsal moderately elongated, with several spines, increasing backward; anal opposite the posterior portion of dorsal, armed with 3 or 4 spines; pectorals with branched rays; ventral fins thoracic, each with a spine and 6 or 7 rays. Vertebræ in increased

number (29). The family is distinguished by the combination of chin barbels, increased number of rays, and small number of branchiostegals. The increased number of ventral rays and the structure of the fins points plainly to Berycoid affinities. According to Boulenger, the skeleton is essentially that of *Beryx*, and the species resemble Mullidæ in the peculiar hyoid barbels, but in no other regard.

A single genus, with a few species, inhabiting rather deep waters in the tropical Atlantic and Pacific.

7. POLYMIXIA Lowe.

Polymixia Lowe, Trans. Cambr. Phil. Soc., 1838, p. 198 (*nobilis*).

Nemobrama Valenciennes, Berher-Webb and Berthelot, Ichth. Iles. Canar., 1844, p. 40 (*webbii*).

Dinemus Poey, Memorias II, 1860, p. 160 (*venustus*).

Characters of the genus included above.

(*πολύς*, many; *μῖξις*, mixing; a mixture of the characters of many groups.)

10. POLYMIXIA JAPONICA Steindachner.

GINME (SILVER EYE).

Polymixia japonica Steindachner, Fische Japans, I, 1883, p. 12, pl. iv, fig. 2, 1883; Tokyo.—Ishikawa, Prel. Cat., 1897, p. 58; Tokyo.

Head $2\frac{5}{6}$ to 3; depth $2\frac{2}{3}$ to $2\frac{3}{4}$; D., V, 33 to 34; A., IV, 15 to 16; P., I, 15 to 16; V., I, 6. Scales 7–60–16. Body long, compressed, with the anterior profile convex and descending from the eye to the snout; posterior profile gradually descending to the caudal fin; posterior profile nearly straight. Scales small and rough. Head compressed and more or less scaly; eye large, 3 in the head and $1\frac{3}{4}$ in the maxillary; snout short, very obtuse, produced, about $1\frac{2}{3}$ in eye and 3 in the maxillary; mouth large, inferior, the maxillary expanded distally until a little more than half the eye and reaching a short distance behind the eye; jaws with broad, rough patches of minute teeth; mandibular barbels reaching the ventrals in smaller specimens; suborbital narrow, about one-third the eye; nostrils close together in front of the eye, the posterior an elongate slit, the anterior rounded and covered by a flap; interorbital space convex, scaled till even with the front margin of the eye, a little less than the eye and 2 in the maxillary; preoperculum and operculum scaly. Gill-opening large, the gill-rakers 5+9, moderate, compressed. Origin of the dorsal nearer the tip of the snout than the base of the caudal; the spinous dorsal with weak spines, graduated to the last, which is the longest and more than half the length of the highest soft rays which includes the first 7 or 8, the rest of the soft dorsal being low and of uniform height; anal spines weak and graduated to the fourth or longest; first anal ray the longest, higher than the fourth anal spine, and similar in shape to the dorsal; pectorals low, short, reaching

beyond the first dorsal rays and about equal to the maxillary; ventrals short, beginning in front of the dorsal and extending for about four-ninths the distance between their own bases and the origin of the anal; caudal deeply forked and the lobes pointed. Lateral line oblique to the caudal peduncle, where it runs straight to the base of the caudal. Caudal peduncle compressed and equal to the eye.

Color in alcohol brown, above and on the back darker and richer; on the sides series of longitudinal stripes of silvery; base of the pectoral black, together with the caudal lobes and the upper portion of the anterior soft dorsal rays; peritoneum black.

Length 8½ inches. Here described from examples from Misaki.

Our numerous specimens were taken at Misaki on long lines by Kumakichi Aoki, the fisherman collector of the marine laboratory of the Imperial University of Tokyo. The species is sufficiently distinct from *Polymixia lowei* of the Atlantic, having smaller scales and larger fins. It is known to fishermen as *Ginme* or Silver Eye.

Family V. MONOCENTRIDÆ.

PINE-CONE FISHES.

The characters of the family are those of the single genus, *Monocentris*. Two species are known, Japanese and Australian. The single genus is notably unlike any other kind of fish whatever, but it seems to be nearest the Berycoids.

8. MONOCENTRIS Schneider.

Monocentris SCHNEIDER, Syst. Ichth., 1801, p. 100 (*carinatus*).
Lepisacanthus LACÉPÈDE, Hist. Nat. Poiss., III, 1802, p. 321 (*japonicus*).

Body short, deep, compressed, covered with very large bony scales, joined to form a coat of mail. Snout blunt, rounded, protruding beyond the mouth; mouth moderate, villiform; teeth on jaws and palatines, none on vomer; eye moderate; branchiostegals 8; opercular bones entire; suborbitals with radiating ridges. Dorsal spines isolated; soft dorsal moderate; ventrals reduced to a strong spine and 3 soft rays. Caudal not forked. According to Boulenger, the skeleton of *Monocentris* show some affinity to that of the *Berycidæ*, but differs considerably in "the total absence of ribs on any of the vertebræ anterior to the seventh."

(μόνος, one; κέντρον, spine.)

11. MONOCENTRIS JAPONICUS (Houttuyn).

MATSUKASA UWO (PINE-CONE FISH); MATSUKASAGO (PINE SCULPIN); TAIMUKO-NO-GENPACHI[a] (DICK, THE BRIDEGROOM FISH).

Gasterosteus japonicus HOUTTUYN, Act. Soc. Harl., XX, 1782, pl. II, p. 329, Nagasaki.
Sciæna japonica (*cataphracta*) THUNBERG, Nor. Act. Sci. Succ., XI, 1790, p. 102, pl. III; Nagasaki.

[a] *Genpachi*, a boy's name corresponding to Tom or Dick.

Monocentris cataphracta Bleeker, Kon. Ak. Wet. Amob., 1853, p. 5; Kaminoseki.

Lepisacanthus japonicus Lacépède, Hist. Nat. Poiss., III, 1802, p. 321 (after Houttuyn).

Monocentris japonicus Cuvier and Valenciennes, Hist. Poiss., IV, 1829, p. 461, pl. xcvii; Japan (Coll. Tilesius)—Schlegel, Fauna Japonica, 1847, p. 50, pl. xxii, fig. 1; Nagasaki—Steindachner, Fische Japans, I, 1883, p. 9; Enoshima, Nagasaki, Kanagawa, Philippines.

Monocentris carinata Schneider, Syst. Ichth., 1801, p. 100, pl. xxiv; Japan (called *Monocentris cataphracta* on plate).

Head $2\frac{1}{4}$ to $2\frac{1}{3}$; depth $1\frac{2}{3}$ to $1\frac{3}{4}$; D., V or VI; 11 to 12; A. 10; P. I, 13; V. I 3; scales 2-12 to 14 4. Body deep, compressed, covered with large scales, which are very roughly striated and each with a median keel armed with a series of several backwardly projecting short spines, so as to form 7 rows along the sides; there is a ventral keel similar to the scales along the sides. Head without scales but very rough, the ridges elevated and with papillose skin stretch'ng from one to the other, leaving large mucous cavities underneath; the depth of the head about equal to its length; eye a little in front of the middle, $3\frac{1}{2}$ in the head, greater than the snout, and $1\frac{1}{2}$ in the interorbital space; nostrils directly in front of the eye, the posterior very much the larger; snout very round, obtuse, and projecting beyond the mouth; the mouth large, oblique, and inferior, with the maxillary extending to below the posterior margin of the eye; jaws without teeth; interorbital space roundly convex; gill-opening rather large, with well-developed flap and forming a free fold across the isthmus; gill-rakers somewhat numerous, slender, and at least as long as half of eye; the skin between the jaws below is coarsely papillose or fringed; origin of the dorsal a little behind the gill-opening; spinous dorsal composed of at least 3, very often 4, very robust, strong, pointed spines, inclined alternately somewhat to one side of the body or the other, the first always the shortest, and the second always the longest, the other dorsal spines obsolete; soft dorsal high in the middle with rounded edge; anal high in front and sloping behind; higher than the soft dorsal; pectorals low, $1\frac{1}{2}$ in the head; ventral spine very strong, long, $1\frac{1}{3}$ in the head, and reaching the anus caudal with both lobes pointed, the edge emarginate; caudal peduncle a little less than the eye.

Color in alcohol, pale brown; each scale with skin at its base blackish, forming a reticulated pattern as it shows along the edges; jaws, blackish; several blackish bands radiating from the eye and around the opercles. Total length, 5 inches.

Here described from Nagasaki examples.

Color in life, coppery brown above and on the fins; sides and below, coppery yellow; outlines of scales, blackish.

This extraordinary little fish is rather common in clear waters with rocky bottom off the coast of Japan. Our numerous specimens are from Tokyo, Misaki, Wakanoura, Sagami Bay, Suruga Bay, Nagasaki, and Nafa in Okinawa.

Houttuyn observes in regard to this species: "I have never seen the equal of it." It is certainly one of the most aberrant of all known fishes.

SUMMARY.

Family I. Berycidæ.

1. *Beryx* Cuvier.

1. *decadactylus* Cuvier and Valenciennes.
2. *splendens* Lowe; Tokyo, Yokohama.

Family II. Trachichthyidæ.

2. *Gephyroberyx* Boulenger.

3. *japonicus* (Döderlein); Suruga Bay.

3. *Hoplostethus* Cuvier and Valenciennes.

4. *mediterraneus* Cuvier and Valenciennes; Sagami Bay, Suruga Bay, Kishyu.

4. *Paratrachichthys* Waite.

5. *prosthemius* Jordan and Fowler; Suruga Bay.

Family III. Holocentridæ.

5. *Ostichthys* Jordan and Evermann.

6. *japonicus* (Cuvier and Valenciennes); Misaki, Giran.

6. *Holocentrus* Scopoli

7. *spinosissimus* Schlegel; Wakanoura.
8. *alboruber* Lacépède; Okinawa.
9. *ittodai* Jordan and Fowler; Okinawa.

Family IV. Polymixiidæ.

7. *Polymixia* Lowe.

10. *japonica* Steindacher; Misaki.

Family V. Monocentridæ.

8. *Monocentris* Schneider.

11. *japonicus* (Houttuyn); Tokyo, Misaki, Wakanoura, Suruga Bay, Nagasaki and Nafa.

JAPANESE STALK-EYED CRUSTACEANS.

By Mary J. Rathbun,

Second Assistant Curator, Division of Marine Invertebrates.

The collection here described was obtained by Dr. David S. Jordan and Mr. J. O. Snyder during the summer of 1900, while making a special investigation of the fishes of Japan under the auspices of the Hopkins Laboratory of Stanford University. The specimens were taken along shore, mostly in the seine. The new species number nine shrimps and one hermit crab. To show the relation of the species of *Parapenæus* of the *velutinus* type, descriptions of two additional species in the U. S. National Museum are included.

The drawings were made by Miss Sigrid Bentzon. The type specimens are in the U. S. National Museum.

Order DECAPODA.

Suborder BRACHYURA.

Family OCYPODIDÆ.

EUCRATE CRENATA de Haan.

Cancer (*Eucrate*) *crenatus* de Haan, Fauna Japon., Crust., 1835, p. 51, pl. xv, fig. 1.

Eucrate crenata Alcock, Jour. Asiatic Soc. Bengal, LXIX, 1900, p. 300, and synonymy.

Wakanoura, Kii; 2 males, 1 female.

CARCINOPLAX LONGIMANUS (de Haan).

Cancer (*Curtonotus*) *longimanus* de Haan, Fauna Japon., Crust., 1835, p. 50, pl. vi, fig. 1.

Carcinoplax longimanus Alcock, Jour. Asiatic Soc. Bengal, LXIX, 1900, p. 303, and synonymy.

Wakanoura, Kii; 4 males, 3 females, large; 15 males, 13 females, medium.

CARCINOPLAX VESTITA (de Haan).

Cancer (*Curtonotus*) *vestitus* DE HAAN, Fauna Japon., Crust., 1835, p. 51, pl. v, fig. 3.

Carcinoplax vestitus MILNE EDWARDS, Ann. Sci. Nat. (3), Zool., XVIII, 1852, p. 164 [128].

Wakanoura, Kii; 6 males, 3 females.

Family GRAPSIDÆ.

HEMIGRAPSUS SANGUINEUS (de Haan).

Grapsus (*Grapsus*) *sanguineus* DE HAAN, Fauna Japon., Crust., 1835, p. 58, pl. XVI, fig. 3.

Heterograpsus sanguineus MILNE EDWARDS, Ann. Sci. Nat. (3), Zool., XX, 1853, p. 193 [159].

Tokyo, 9 males; Misaki, Sagami, 1 male; Wakanoura, Kii, 1 female.

ERIOCHEIR JAPONICUS de Haan.

Grapsus (*Eriocheir*) *japonicus* DE HAAN, Fauna Japon., Crust., 1835, p. 59, pl. XVII.

Eriochirus japonicus MILNE EDWARDS, Ann. Sci. Nat. (3), Zool., XX, 1853, p. 176 [142].

Aomori, Rikuoku; Same, Rikuoku; Wakanoura, Kii; Chikugo River, Kurume, Chikugo.

PLATYGRAPSUS DEPRESSUS (de Haan).

Grapsus (*Platynotus*) *depressus* DE HAAN, Fauna Japon., Crust., 1835, p. 63, pl. VIII, fig. 2.

Platygrapsus depressus STIMPSON, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 104 [50].

Hakodate, Hokkaido.

SESARMA (HOLOMETOPUS) HÆMATOCHEIR (de Haan).

Grapsus (*Pachysoma*) *hæmatocheir* DE HAAN, Fauna Japon., Crust., 1835, p. 62, pl. VIII, fig. 4.

Holometopus hæmatocheir MILNE EDWARDS, Ann. Sci. Nat. (3), Zool., XX, 1853, p. 188 [154].

Mogi, near Nagasaki.

Family PILUMNIDÆ.

LIAGORE RUBROMACULATA de Haan.

Cancer (*Liagore*) *rubromaculatus* DE HAAN, Fauna Japon., Crust., 1835, p. 49, pl. V, fig. 1.—BERTHOLD, Abh. Königl. Ges. Wiss. Göttingen, III, 1845, p. 18.

Wakanoura, Kii; 16 males, 9 females.

ATERGATIS OCYROE (Herbst).

Cancer ocyroe HERBST, Natur. d. Krabben u. Krebse, III, Pt. 2, 1801, p. 20, pl. LIV, fig. 2.
Atergatis floridus ALCOCK, Jour. Asiatic Soc. Bengal, LXVII, 1898, p. 98, and synonymy.

Misaki, Sagami.

XANTHO SCABERRIMUS Walker.

Xantho scaberrimus WALKER, Jour. Linn. Soc. London, XX, 1887, pp. 109 and 115, pl. VII, figs. 1–4.
Xantho (*Lophoxanthus*) *scaberrimus* ALCOCK, Jour. Asiatic Soc. Bengal, LXVII, 1898, p. 116.

Wakanoura. Kii; 1 female.

LEPTODIUS EXARATUS (Milne Edwards).

Chlorodius exaratus MILNE EDWARDS, Hist. Nat. Crust., I, 1834, p. 402.
Leptodius exaratus A. MILNE EDWARDS, Nouv. Arch. Mus. Hist. Nat. Paris, IV, 1868, p. 71.
Xantho (*Leptodius*) *exaratus* ALCOCK, Jour. Asiatic Soc. Bengal, LXVII, 1898, p. 118, and synonymy.

Misaki, Sagami.

Family PORTUNIDÆ.

OVALIPES BIPUSTULATUS (Milne Edwards).

Platyonichus bipustulatus MILNE EDWARDS, Hist. Nat. Crust., I, 1834, p. 437, pl. XVII, figs. 7–10.
Corystes (*Anisopus*) *punctata* DE HAAN, Fauna Japon., Crust., 1835, p. 44, pl. II, fig. 1.
Ovalipes bipustulatus RATHBUN, Proc. U. S. Nat. Mus., XXI, 1898, p. 597.

Same, Rikuoku.

LIOCARCINUS STRIGILIS (Stimpson).

Portunus (*Portunus*) *corrugatus* DE HAAN, Fauna Japon., Crust., 1835, p. 40 (not *P. corrugatus* Leach).
Portunus strigilis STIMPSON, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 38 [35].

Misaki, Sagami; Wakanoura, Kii; Nagasaki, Hizen.

As compared to *L. corrugatus* (Leach), *L. strigilis* is longer and narrower length 0.85 to 0.87 of width; in *L. corrugatus*, length 0.79 to 0.8 of width. The antero-lateral margin is relatively longer than the postero-lateral. The median tooth of the front is more triangular, its sides at right angles to each other, tip acute; in *L. corrugatus* the sides form an obtuse angle, which is bluntly rounded.

Dimensions.—Male, length 22.6 mm., width 26.6 mm.; female, length 26.2 mm., width 30 mm. Stimpson's type was very small, said to be 0.28 of an inch long, 0.3 of an inch wide. This is probably

an error, as in his figure (unpublished) the carapace measures 13.5 mm. long by 15.5 mm. broad; the figure is enlarged twice, making the actual measurements 6.75 mm. by 7.75 mm., or 0.26 by 0.3 inch.

PORTUNUS PELAGICUS (Linnæus).

Cancer pelagicus LINNÆUS, Syst. Nat., 10th ed., I, 1758, p.626.
Portunus pelagicus FABRICIUS, Suppl. Ent. Syst., 1798, p. 367.
Neptunus pelagicus ALCOCK, Jour. Asiatic Soc. Bengal, LXVII, 1898, p. 34, part; not all references to synonymy.

Kawatana; 1 male, 1 female.

PORTUNUS TRITUBERCULATUS (Miers).

Portunus (*Neptunus*) *pelagicus* DE HAAN, Fauna Japon., Crust., 1835, p. 37, pls. IX and X.
Neptunus trituberculatus MIERS, Ann. Mag. Nat. Hist. (4), XVII, 1876, p. 221, and (5), V, 1880, p. 238.
Neptunus (*Neptunus*) *pelagicus* var. *trituberculatus* ORTMANN, Zool. Jahrb., Syst. VII, 1893, p. 74.

Wakanoura, Kii, 1 female; Yokohama, 1 male, 1 female, and Hakodate, 1 female, U. S. Fish Commission steamer *Albatross;* Japan, 3 males, 2 females.

This form seems to me specifically distinct from *P. pelagicus*, of which 32 specimens have been examined. In *P. trituberculatus*, the granules of the carapace are much finer and more numerous. There is a very prominent lump on the postgastric and two on the cardiac region. The front has only two teeth between the inner orbital teeth, the two small teeth at the base of the epistomial spine being absent. The middle lobe of the supraorbital border is rounded, not dentiform nor spiniform. The anterior margin of the arm carries 4 (in one case 3) spines. The length of the sixth abdominal somite in the male is greater than its proximal width; in *P. pelagicus* less, or just equal to that width. The sternum of the female is coarsely granulate; carinæ of second and third abdominal segments laterally strongly produced in an acute tooth or spine.

PORTUNUS GLADIATOR Fabricius.

Portunus gladiator FABRICIUS, Suppl. Ent. Syst., 1798, p. 368.
Neptunus (*Amphitrite*) *gladiator* ALCOCK, Jour. Asiatic Soc. Bengal, LXVIII, 1899, p. 35, and synonymy.

Wakanoura, Kii; 1 male, 1 female.

Amphitrite media Stimpson, as figured by him in his unpublished report on the Crustacea of the North Pacific Exploring Expedition, differs from *P. gladiator* in the nearly equal and equally advanced teeth of the front, the appressed and overlapping antero-lateral teeth, the shorter lateral spine.

PORTUNUS HASTATOIDES Fabricius.

Portunus hastatoides FABRICIUS, Suppl. Entom. Syst., 1798, p. 368.
Neptunus (Hellenus) hastatoides ALCOCK, Jour. Asiatic Soc. Bengal, LXVIII, 1899, p. 38, and synonymy.

Wakanoura, Kii, 1 young male, 1 female; Nagasaki, Hizen, 4 males, 5 females.

CHARYBDIS JAPONICA (A. Milne Edwards).

Portunus (Charybdis) 6—dentatus DE HAAN, Fauna Japon., Crust., 1835, p. 41, pl. XII, fig. 1. Not *Cancer sexdentatus* Herbst.
Goniosoma japonicum A. MILNE EDWARDS, Arch. Mus. Hist. Nat. Paris, X, 1861, p. 373.

Matsushima, Rikuzen; Tokyo; Wakanoura, Kii; Onomichi, Bingo; Nagasaki, Hizen.

CHARYBDIS MILES de Haan.

Portunus (Charybdis) miles DE HAAN, Fauna Japon., Crust., 1835, p. 41, pl. XI, fig. 1.
Charybdis (Goniosoma) miles ALCOCK, Jour. Asiatic Soc. Bengal, LXVIII, 1899, p. 62, and synonymy.

Wakanoura, Kii.

CHARYBDIS VARIEGATA (Fabricius).

Portunus variegatus FABRICIUS, Suppl. Ent. Syst., 1798, p. 364.
Charybdis (Goniosoma) variegata ALCOCK, Jour. Asiatic Soc. Bengal, LXVIII, 1899, p. 60, and synonymy.

Wakanoura, Kii, 1 male, 1 female; Nagasaki, Hizen, 2 males, 1 female.

The specimens have been compared with a photograph of Fabricius's types in the museum at Copenhagen.

CHARYBDIS TRUNCATA (Fabricius).

Portunus truncatus FABRICIUS, Suppl. Ent. Syst., 1798, p. 365.
Portunus (Thalamita) truncatus DE HAAN, Fauna Japon., Crust., 1835, p. 43, pl. II, fig. 3, and pl. XII, fig. 3, male only.
Goniosoma ornatum A. MILNE EDWARDS, Arch. Mus. Hist. Nat. Paris, X, 1861, pp. 376 and 385. Not *G. truncatum* A. Milne Edwards, Arch. Mus. Hist. Nat. Paris, X, 1861, pp. 380 and 385, pl. XXXIV, fig. 4.
Charybdis (Goniohellenus) ornata ALCOCK, Jour. Asiatic Soc. Bengal, LXVIII, 1899, p. 64, and synonymy.
Charybdis (Gonioneptunus) truncata BORRADAILE, Fauna and Geog. Maldive and Laccadive Arch., I, 1902, p. 200.

Wakanoura, Kii; Nagasaki, Hizen.

The specimens were compared with a photograph of the Fabrician type.

CHARYBDIS SUBORNATA (Ortmann).

Portunus (Thalamita) truncatus DE HAAN, Fauna Japon., Crust., 1835, p. 43, pl. XII, fig. 3, female only; 1849, p. 244.
Portunus (Charybdis) truncatus, varietas, DE HAAN, Fauna Japon., Crust., 1838, p. 65, pl. XVIII, fig. 2.
Gonioneptunus subornatus ORTMANN, Zool. Jahrb., Syst., VII, 1893, p. 79, pl. III, fig. 9.
Charybdis (Gonioneptunus) truncata ALCOCK, Jour. Asiatic Soc. Bengal, LXVIII, 1899, p. 67. Not *Goniosoma truncatum* A. Milne Edwards, Arch. Mus. Hist. Nat. Paris, X, 1861, pp. 380 and 385, pl. XXXIV, fig. 4.

Wakanoura, Kii; Onomichi, Bingo.

THALAMITA SIMA Milne Edwards.

Thalamita sima MILNE EDWARDS, Hist. Nat. Crust., I, 1834, p. 460.—ALCOCK, Jour. Asiatic Soc. Bengal, LXVIII, 1899, p. 81, and synonymy.
Portunus (Thalamita) arcuatus DE HAAN, Fauna Japon., Crust., 1835, p. 43, pl. II, fig. 2; pl. XIII, fig. 1.

Misaki, Sagami; Nagasaki, Hizen.

Family CANCRIDÆ.

TELMESSUS ACUTIDENS (Stimpson).

Cheiragonus acutidens STIMPSON, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 40 [37].
Telmessus acutidens BENEDICT, Proc. U. S. Nat. Mus., XV, 1892, p. 228, pl. XXVI, fig. 1, and synonymy.

Mororan, Hokkaido; Hakodate, Hokkaido (many young); Aomori, Rikuoku.

Family MAIIDÆ.

HUENIA PROTEUS de Haan.

Maja (Huenia) elongata DE HAAN, Fauna Japon., Crust., pl. XXIII, figs. 4, 5.[a]
Maja (Huenia) heraldica DE HAAN, Fauna Japon., Crust., pl. XXIII, fig. 6.[a]
Maja (Huenia) proteus DE HAAN, Fauna Japon., Crust., 1839, p. 95.
Huenia proteus ALCOCK, Jour. Asiatic Soc. Bengal, LXIV, 1895, p. 195, and synonymy.

Nagasaki, Hizen.

PUGETTIA QUADRIDENS (de Haan).

Pisa (Halimus) quadridens DE HAAN, Fauna Japon., Crust., pl. XXIV, fig. 2, 1838.[b]
Pisa (Halimus) incisa DE HAAN, Fauna Japon., Crust., pl. XXIV, fig. 3, 1838.
Pisa (Menaethius) incisa DE HAAN, Fauna Japon., Crust., pl. G.
Pisa (Menaethius) quadridens DE HAAN, Fauna Japon., Crust., pl. G.
Pisa (Menoethius) quadridens DE HAAN, Fauna Japon., Crust., 1839, p. 97.
Pisa (Menoethius) incisus DE HAAN, Fauna Japon., Crust., 1839, p. 98.
Pugettia quadridens RATHBUN, Proc. U. S. Nat. Mus., XVII, 1894, p. 71, and synonymy.

Hakodate, Hokkaido, and Misaki, Sagami; specimens of typical form.

[a] Specific name corrected in text.

[b] Pp. 65–72 and pls. XXIV, E and F, Fauna Japon., Crust., appeared in 1838, according to Bull. Sci. Phys. Nat. Neerlande, Aug. 31, 1838.

DOCLEA CANALIFERA Stimpson.

Doclea canalifera STIMPSON, Proc. Acad. Nat. Sci. Phila., IX, 1857, p. 217 [23].—ALCOCK, Jour. Asiatic Soc. Bengal, LXIV, 1895, p. 228.

Doclea japonica ORTMANN, Zool. Jahrb., Syst., VII, 1893, p. 46, pl. III, fig. 4.—ALCOCK, Jour. Asiatic Soc. Bengal, LXIV, 1895, p. 227.

Wakanoura, Kii; 3 males, 3 females.

The two largest males agree with descriptions of *D. japonica;* in the four smaller specimens, however, the spines are all better developed, the posterior of the branchial spines being the largest one on the lateral margin. Stimpson's description was based on a young male, of which a figure was made, but is yet unpublished.

HALIMUS DIACANTHUS (de Haan).[a]

Pisa (Naxia) diacantha DE HAAN, Fauna Japon., Crust., 1838, pl. XXIV, fig. 1; 1839, p. 96, and pl. G.

Hyastenus diacanthus ALCOCK, Jour. Asiatic Soc. Bengal, LXIV, 1895, p. 210, and synonymy.

Wakanoura, Kii; Nagasaki, Hizen.

MICIPPA PHILYRA (Herbst).

Cancer philyra HERBST, Natur. Krabben u. Krebse, III, Pt. 3, 1803, p. 51, pl. LVIII, fig. 4.

Micippa philyra ALCOCK, Jour. Asiatic Soc. Bengal, LXIV, 1895, p. 249, and synonymy.

Wakanoura, Kii.

MICIPPA THALIA (Herbst).

Cancer thalia HERBST, Natur. Krabben u. Krebse, III, Pt. 3, 1803, p. 50, pl. LVIII, fig 3.

Micippa thalia ALCOCK, Jour. Asiatic Soc. Bengal, LXIV, 1895, p. 251, and synonymy.

Nagasaki, Hizen.

Family PARTHENOPIDÆ.

LAMBRUS VALIDUS de Haan.

Parthenope (Lambrus) valida DE HAAN, Fauna Japon., Crust., 1839, p. 90, pl. XXI, fig. 1, and pl. XXII, fig. 1.

Lambrus validus ORTMANN, Zool. Jahrb., Syst., VII, 1893, p. 414, and synonymy.

Wakanoura, Kii.

LAMBRUS LACINIATUS de Haan.

Parthenope (Lambrus) laciniata DE HAAN, Fauna Japon., Crust., 1839, p. 91, pl. XXII, figs. 2 and 3 (*valida* on plate).

Lambrus laciniatus ORTMANN, Zool. Jahrb., Syst., VII, 1893, p. 415, and synonymy.

Wakanoura, Kii; Onomichi, Bingo; Nagasaki, Hizen.

[a] I have shown elsewhere (Proc. Biol. Soc. Wash., XI, 1897, p. 157) that *Hyastenus* is a synonym of *Halimus.*

Family CALAPPIDÆ.

CALAPPA PHILARGIUS (Linnæus).

Calappa philargius ALCOCK, Jour. Asiatic Soc. Bengal, LXV, 1896, p. 145, and synonymy.

Nagasaki, Hizen; 1 female.

Family MATUTIDÆ.

MATUTA LUNARIS (Forskål).

Cancer lunaris FORSKÅL, Descriptiones Animalium, 1775, p. 91. Not *C. lunaris* Rumph, 1705.

Cancer victor FABRICIUS, Ent. Syst., II, 1793, p. 449.

Matuta victor FABRICIUS, Suppl. Ent. Syst., 1798, p. 369.—ALCOCK, Jour. Asiatic Soc. Bengal, LXV, 1896, p. 160, and synonymy.

Nagasaki, Hizen; 1 female.

Matuta lunaris Alcock[a] should be known as *M. planipes* Fabricius. The original of Herbst's pl. VI. fig. 44, is probably not extant; it was not to be found during my visit to the Berlin Museum in 1896.

Family LEUCOSIIDÆ.

PERSEPHONA FUGAX (Fabricius).

Myra fugax ALCOCK, Jour. Asiatic Soc. Bengal, LXV, 1896, p. 202, and synonymy.

Wakanoura, Kii (numerous); Nagasaki, Hizen.

I think that the genus *Myra* Leach is not distinct from *Persephona* Leach.

LEUCOSIDES LONGIFRONS (de Haan).

Leucosia longifrons ALCOCK, Jour. Asiatic Soc. Bengal, LXV, 1896, p. 220, and synonymy.

Wakanoura, Kii; 1 male.

Leucosides Rathbun, 1897,[b] was substituted for *Leucosia* Leach, not *Leucosia* Fabricius, restricted by Latreille.

ARCANIA SEPTEMSPINOSA (Fabricius).

Arcania septemspinosa ALCOCK, Jour. Asiatic Soc. Bengal, LXV, 1896, p. 265, and synonymy.

Wakanoura, Kii.

ARCANIA UNDECIMSPINOSA de Haan.

Arcania undecimspinosa ALCOCK, Jour. Asiatic Soc. Bengal, LXV, 1896, p. 266, and synonymy.

Wakanoura, Kii; Nagasaki, Hizen.

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[a] Jour. Asiatic Soc. Bengal, LXV, 1896, p. 161.

[b] Proc. Biol. Soc. Wash., XI, p. 160.

Family DORIPPIDÆ.

DORIPPE DORSIPES (Linnæus).

Dorippe dorsipes Alcock, Jour. Asiatic Soc. Bengal, LXV, 1896, p. 277, and synonymy.

Wakanoura, Kii; Nagasaki, Hizen.

DORIPPE JAPONICA de Siebold.

Dorippe japonica de Siebold, Spicilegia Faunæ Japonicæ, 1824, p. 14.—Férussac, Bull. des Sci., IV, 1825, p. 87.—de Haan, Fauna Japon., Crust., 1849, p. 122.
Dorippe callida de Haan, Fauna Japon., Crust., pl. xxxi, fig. 1.[a] Not Fabricius.

Wakanoura, Kii; 2 females.

DORIPPE GRANULATA de Haan.

Dorippe sima de Haan, Fauna Japon., Crust., pl. xxxi, fig. 2.[a] Not Milne Edwards.
Dorippe granulata de Haan, Fauna Japon., Crust., 1839, p. 122. Not *D. granulata* Alcock, Jour. Asiatic Soc. Bengal, LXV, 1896, p. 279.

Minyako, Rikuzen; Wakanoura, Kii; Nagasaki, Hizen.

D. granulata is very different from *D. facchino* (Herbst). The surface of the carapace is covered with granules, especially dense on the branchial regions, smallest on the protogastric and frontal regions, absent from the sulci and from the margin of the gastric region. The width between the tips of the exorbital teeth is only half or less than half the greatest width of the carapace. The spine at the lower inner angle of the orbit is very short, not nearly as advanced as the front. The roof of the endostomial canal projects as a slight rim beyond the front. The outer surface of the chelipeds is granulate except on the fingers, and, in the female and the smaller cheliped of the male, on the lower central and distal portion of the palm. The margins and carinæ of the second and third pairs of legs, save on the dactyli, are granulate, the granules very fine on the propodi.

Dimensions.—Male, length 28.3 mm., width 32.5 mm., exorbital width 14.6 mm., length of second ambulatory leg 76 mm. Female, length 24.6 mm., width 27.6 mm., exorbital width 13.4 mm., length of second ambulatory leg 65 mm.

Suborder ANOMURA.

Family RANINIDÆ.

RANINA RANINA (Linnæus).

Cancer raninus Linnæus, Syst. Nat., 10th ed., I, 1758, p. 625.
Ranina scabra, serrata, and *dentata* of authors.

Misaki, Sagami, 1 male, 1 female; Nagasaki, Hizen, 1 male.

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[a] Specific name corrected in text.

Family DROMIIDÆ.

DROMIA DORMIA (Linnæus).

Cancer Dormia LINNÆUS, Amœn. Acad., VI, 1763, p. 413; Syst. Nat., 12th ed., I, Pt. 2, 1767, p. 1043.

Dromia Rumphii ALCOCK, Jour. Asiatic Soc. Bengal, LXVIII, 1899, p. 137, and synonymy.

Wakanoura, Kii; 1 male.

Family LATREILLIIDÆ.

LATREILLIA VALIDA de Haan.

Latreillia valida DE HAAN, Fauna Japon., Crust., 1839, p. 107, pl. XXX, fig. 1.—HENDERSON, Challenger Rept., XXVII, 1888, p. 24.

Wakanoura, Kii; 1 female with ova, lacking the chelipeds. The frontal spines have a subterminal spinule.

Family LITHODIDÆ.

CRYPTOLITHODES EXPANSUS Miers.

Cryptolithodes expansus MIERS, Proc. Zool. Soc. London, 1879, pp. 21 and 47.

Minyako, Rikuzen, 1 male.

Length 51.6 mm., length of rostrum 9.5 mm., width 78.9 mm.; length measured from outer angle of orbit backward 45 mm.

Carapace transversely oblong, without lateral angles, covered with minute vesicular setæ springing from minute punctæ, and also with larger punctæ. There is a prominent protuberance on the cardiac region, and one on either side of it on the branchial region, the three forming a transverse series and springing from a common base. A similar prominence occupies the gastric region, and through it a median ridge runs on to the distal half of the rostrum. The anterior half of each lateral expansion is occupied by a low prominence which is tuberculated. The right expansion is a little larger than the left. The margin of the carapace is furnished with small blunt teeth or tubercles at irregular and remote intervals; these number about 34, the largest ones being at the outer angle of the orbit. The rostrum is moderately deflexed, projects well beyond the anterior margin of the carapace, is nearly as long as its width at base,

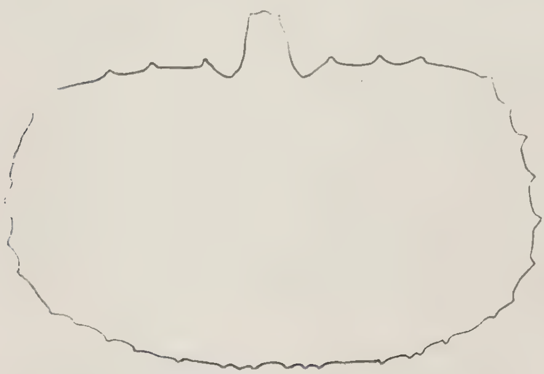

FIG. 1.—CRYPTOLITHODES EXPANSUS, OUTLINE OF CARAPACE, × $\frac{4}{5}$.

sides gradually converging and slightly convex, extremity truncate, save for a small median tubercle.

The eyes reach half the length of the rostrum. The second segment of the outer antennæ has a bispinose outer crest, one spine pointing forward, the other backward. The acicle is much broader than its axial length; its distal margin (which is directed obliquely) is concave.

In the left cheliped (the right is missing), the basis and ischium are tuberculous below; merus tricarinate, the inner carina cut into 4 irregular teeth, and continuing a similar carina on the ischium; the upper surface of the carpus is rough, the inner margin and angle laminar, the outer carina blunt, a blunt tooth at lower distal angle. Palm and fingers tuberculous inside and out, a sharp carina on upper surface of palm, ending distally in an acute conical tooth, a blunt carina on lower margin of propodus. Fingers considerably longer than upper margin of palm, almost meeting when closed, dactylus carinated above, carina ending proximally in a lobe. The ischium of the ambulatory legs is provided with a tooth on the posterior distal angle of the upper margin, this tooth increasing in size from the first to the third pair. Margins of succeeding joints broadly laminate; the meri with 1 superior and 2 inferior laminæ, carpi with 1 superior, propodi and dactyli with 1 superior and 1 inferior. The legs in a natural position are concealed, but when extended, the last and half of the penult segment reach beyond the carapace.

The length of the abdomen exceeds by a small particle its width at base. The first segment is very short, almost linear; its width is less than half the width of the second. The second has a median suture and each half is ventrally concave. The sutures between the lateral plates alternate with those between the segments. The third to sixth segments, inclusive, taken together are concave; the third is narrow and transversely sulcate.

Family PAGURIDÆ.

DARDANUS Paulson.

Pagurus Fabricius, Syst. Entom., 1775, p. 410 (part).—Stimpson, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 233 [71].

Dardanus Paulson, Crust. Red Sea, 1875, p. 90.

Pagurias Benedict, Bull. U. S. Fish Comm. for 1900, II, 1901, p. 141.

Dardanus, a genus made by Paulson for *Pagurus depressus* Heller, is shown by Kossmann[a] not to differ from *Pagurus* (so called). The name *Dardanus* is therefore available in place of *Pagurias* Benedict, the name *Pagurus* having been transferred to the group called *Eupagurus* by Brandt.

[a] Zool. Ergeb. Reise Rothen Meeres, 1877, p. 76.

DARDANUS PUNCTULATUS (Olivier).

Pagurus punctulatus Olivier, Encyc. Méth., Hist. Nat., Insectes, VIII, 1811, p. 641.—Ortmann, Zool. Jahrb., Syst., VI, 1892, p. 286, and synonymy.

Wakanoura, Kii; two specimens, one in shell of *Pyrula reticulata* Lamarck.[a]

DARDANUS SCULPTIPES (Stimpson).

Pagurus setifer de Haan, Fauna Japon., Crust., 1849, p. 209 (not Milne Edwards).

Pagurus sculptipes Stimpson, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 246 [84].—Ortmann, Zool. Jahrb., Syst., VI, 1892, p. 287, and synonymy; X, 1897, p. 275.

Wakanoura, Kii; 12 specimens in shells of *Dolium variegatum* Lamarck, *Ranella albivaricosa* Roe, *Fusus inconstans* Lischke, *Septa nodifera* Lamarck, and *Hemifusus tornatinus* Gmelin.

DARDANUS IMPRESSUS (de Haan).

Pagurus impressus de Haan, Fauna Japon., Crust., 1849, p. 207, pl. xlix, fig. 3.

Wakanoura, Kii; 1 male in shell of *Dolium fimbriatum* Sowerby.

DARDANUS HAANII, new name.

Pagurus asper de Haan, Fauna Japon., Crust., 1849, p. 208, pl. xlix, fig. 4.—Stimpson, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 246 [84]. Not *P. asper* Milne Edwards, 1848.

Misaki, Sagami; 1 male, larger than the one figured by de Haan, in shell of *Turbo japonicus* Roe. The thorax measures 28 mm. long, the larger hand 21.6 mm. long on its lower margin.

The peduncle of the outer antenna is a little longer than the eye. The lower margin of the ischium of the left cheliped has a row of 3 molariform tubercles. Lower inner margin of ischium and merus armed with stout irregular spines, one at the proximal end of merus much the strongest. Outer margin of merus denticulate; from this margin a short row of tubercles extends along lower surface; upper margin squamose, a terminal spine. Carpus spinose; 4 spines on inner margin, 4 smaller on anterior margin; 2 oblique intermediate rows, one of 5 spines terminating at inner distal angle, the other of 3 spines; lower distal margin in part cristiform and denticulate.

The depth of the palm is greater than its width; lower margin marked by a sinuous line of strong molariform tubercles; lower half of outer surface nearly smooth, densely punctate, and with fine granules near the margins; upper half of surface armed with tubercles arranged for the most part in 4 or 5 longitudinal rows, with some granules interspersed; near the upper margin they become stronger,

[a] The shells mentioned in this paper were named by Mr. C. T. Simpson.

and somewhat spiniform; the innermost row of 4 spines runs along the proximal three-fifths of the palm; the next row, of 4 spines also, occupies only the distal half. The pollex has a row of pearly granules near the upper margin; the opposing margins of the fingers are dentate, fitting neatly together, the proximal teeth very fine; the dactylus carries 3 rows of tubercles on its outer surface.

PAGURUS MIDDENDORFFII Brandt.

Pagurus (*Eupagurus*) *middendorffii* Brandt, in Middendorff's Sibir. Reise, II, Pt. 1, 1851, p. 108, pl. v, figs. 1–16.

Eupagurus middendorffii Stimpson, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 250 [88].

Eupagurus middendorffi Ortmann, Zool. Jahrb., Syst., VI, 1892, p. 301.

Mororan, Hokkaido, 2 small; Hakodate, Hokkaido, 6 small, in shells of *Litorina* (? *sitchana* Philippi) and *Chlorostoma.*

PAGURUS, sp.

Misaki, Sagami, in shells of *Natica adamsiana* Dunker and *Lampania* sp.; 2 young specimens of a species allied to *P. setosus* (Benedict), *P. kennerlyi* (Stimpson), and *P. constans* (Stimpson). The carpus and palm of the right cheliped have longitudinal rows of spinules, those of the carpus larger than those of the hand, those of the margins scarcely larger than those on the dorsal face.

CLIBANARIUS JAPONICUS, new species.

Mororan, Hokkaido; 1 female (Cat. No. 26151).

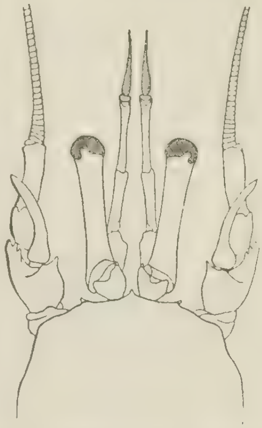

Fig. 2.—Clibanarius japonicus, anterior portion. × 2.

Anterior and lateral portions of carapace rugose; there are about 19 tufts of hair, of which 13 tufts are arranged in a pear-shaped figure. Median tooth of anterior margin more advanced than lateral tooth, and armed with a small spine, which is almost concealed beneath a tuft of hair; just below margin of lateral tooth there is also a small spine pointing outward.

The inner portion of the eye-scales is suboval and entire; at the extremity below the margin is a small spine. Eyes slender, shorter than the front is wide. Antennular peduncle longer than eye; third segment a little longer than second, reaching to end of penult segment of outer maxillipeds. Antennal peduncle not quite so long as eye; acicle slender, sickle-shaped, reaching to middle of last segment.

The chelipeds are more unequal than is usual in the genus. The left is the larger; the merus extends beyond the line of the eyes; its lower surface is bordered by spines within and without; superior

margin with 2 distal spines, 2 smaller subterminal spines. The carpus is longer than broad, has 2 dorsal rows of spines; anterior margin spinose; outer face with a short row of spines at the upper distal end. The propodus is spinose above, the spines arranged in about seven uneven rows; the palm widens considerably distally; its inner margin is little more than half as long as the dactylus; the fingers have each about 3 rows of spines above, their margins meet when closed, the tips cross. The spines have corneous tips. The cheliped is also beset with bunches of hair arising near the bases of the spines.

FIG. 3.—CLIBANARIUS JAPONICUS, LEFT CHELIPED, × $1\frac{2}{3}$.

The right cheliped reaches just to end of palm of left one; the merus falls short of the end of the eyes. The spines are smaller and are less definitely arranged in rows, the palm widens very little toward its distal end, the dactylus is $1\frac{1}{3}$ times longer than inner margin of palm.

FIG. 4.—CLIBANARIUS JAPONICUS, RIGHT CHELIPED, × $1\frac{2}{3}$.

The first ambulatory leg extends beyond left cheliped by half the length of dactylus; both first and second pairs are stout, pilose above, dactylus longer than propodus. The lower margin of the merus and the upper margin of the carpus of the first pair have a row of spines; dactyli of both pairs armed on inner face with several rows of dark spines. These legs are not striated, and in alcohol show no transverse bands of color.

FIG. 5.—CLIBANARIUS JAPONICUS, OUTER FACE OF FIRST AMBULATORY LEG ON RIGHT SIDE, × $1\frac{2}{3}$.

Dimensions.—Length of body 58 mm.; length of cephalothorax 26.2 mm.; distance from tip of rostrum to cervical suture 16 mm.; width of anterior margin 11.1 mm.; length of eye-peduncles 9 mm.; length of propodus of first ambulatory leg, right side, 11.4 mm.; length of dactylus of same 13.4 mm.; length of propodus of second ambulatory leg, right side, 13.4 mm.; length of dactylus of same 15.6 mm.

DIOGENES EDWARDSII (de Haan).

Pagurus edwardsii DE HAAN, Fauna Japon., Crust., 1849, p. 211, pl. L, fig. 1.
Diogenes edwardsi ORTMANN, Zool. Jahrb., Syst., VI, 1892, p. 295.

Wakanoura, Kii (abundant), in shells of *Cassis japonica* Roe, *Eburna japonica* Sowerby, *Polinices ampla* Philippi, *Ranella albivaricosa* Roe, *Nassa gemmulata* Lamarck, *Siphonalia signum* Roe and *Turbo japonicus* Roe.

Nagasaki, Hizen, in shells of *Siphonalia signum* Roe and *Fusus inconstans* Lischke.

Nearly all of the crabs have an actinian[a] attached to the outer surface of the larger palm, while the shells may carry one or more of the same species.

SPIROPAGURUS SPIRIGER (de Haan).

Pagurus spiriger DE HAAN, Fauna Japon., Crust., 1849, p. 206, pl. XLIX, fig. 2.
Spiropagurus spiriger Ortmann, Zool. Jahrb., Syst., VI, 1892, p. 297.

Wakanoura, Kii (abundant), in shells of *Pyrula reticulata* Lamarck, *Cassis japonica* Roe, *Dolium variegatum* Lamarck ?, young, *D. fimbriatum* Sowerby, *Eburnea japonica* Sowerby, *Polinices ampla* Philippi, *Ranella albivaricosa* Roe, *Nassa gemmulata* Lamarck, and *Siphonalia signum* Roe. Nagasaki, Hizen.

Suborder MACRURA.

Family PALINURIDÆ.

PANULIRUS JAPONICUS (de Siebold).

Palinurus japonicus DE SIEBOLD, Spicilegia Faunæ Japonicæ, 1824, p. 15.—FÉRUSSAC, Bull. des Sci., IV, 1825, p. 87.—DE HAAN, Fauna Japon., Crust., 1841, p. 158, pls. XLI and XLII.

Nagasaki, Hizen; 3 specimens of medium size.

Family PENÆIDÆ.

PENÆUS CANALICULATUS (Olivier).

Palæmon canaliculatus OLIVIER, Ency. Méth., Hist. Nat., Entom., VIII, 1811, p. 660.
Penæus canaliculatus MILNE EDWARDS, Hist. Nat. Crust., II, 1837, p. 414.
Penaeus canaliculatus KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 11, pls. I and VII, figs. 1, 1a, 1b, 1c.
Penæus canaliculatus var. *japonicus* BATE, Challenger Rept., XXIV, 1888, p. 245, pl. XXXI; pl. XXXII, fig. 4; pl. XXXVII, fig. 2.

Tokyo; Hiroshima, Aki.

PENÆUS LATISULCATUS Kishinouye.

Penaeus latisulcatus KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 12, pl. II, fig. 2; pl. VII, figs. 2, 2a.

Nagasaki, Hizen; 1 male, 1 female. Also taken at Mogi by Dr. F. C. Dale, U. S. S. *Palos*, June 18, 1881, 1 male, 2 females; and at Tokyo by the U. S. Fish Commission steamer *Albatross*, October, 1896, 1 male, 1 female, the latter measuring 18.5 cm. long.

[a] A description of this actinian, by Dr. J. Playfair McMurrich, will be found later in this volume.

PENÆUS ASHIAKA Kishinouye.

Penæus semisulcatus STIMPSON, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 44 [113]. Not *P. semisulcatus* de Haan.
Penaeus ashiaka KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 14, pl. III; pl. VII, figs. 4, 4a, 4b (not 3, 3a, 3b).

Tokyo; Wakanoura, Kii; Nagasaki, Hizen. Females only.

This species is very near *P. semisulcatus* de Haan (not = *P. monodon* Fabricius, Kishinouye), but the posterior gastric tooth is further back; the lateral grooves reach distinctly behind that tooth, while in *P. semisulcatus* the grooves fade out near the last tooth; the thelycum is slightly different; the telson is longer than the sixth segment, in *P. semisulcatus* shorter.

PARAPENÆUS AFFINIS (Milne Edwards).

Penæus affinis MILNE EDWARDS, Hist. Nat. Crust., II, 1837, p. 416.
Parapenæus affinis SMITH, Proc. U. S. Nat. Mus., VIII, 1885, p. 176.
Penaeus affinis KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 16, pl. IV, fig. 1; pl. VII, figs. 5, 5a, 5b, 5c.

Onomichi, Bingo; 1 male, 1 female.

PARAPENÆUS INCISIPES (Bate).

Penæus incisipes BATE, Challenger Rept., XXIV, 1888, p. 257, pl. XXXIV, fig. 2.
Penaeus incisipes KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 18, pl. IV, fig. 2; pl. VII, figs. 6, 6a, 6b.

Wakanoura, Kii; Hiroshima, Aki; Nagasaki, Hizen.

PARAPENÆUS JOYNERI (Miers).

Penæus joyneri MIERS, Ann. Mag. Nat. Hist. (5), V, 1880, p. 458, pl. XV, figs. 8–10.
Penaeus joyneri KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 19, pl. V, pl. VII, figs. 7, 7a, 7b, 7c.

Tokyo; 2 males.

PARAPENÆUS CURVIROSTRIS (Stimpson).

Penæus curvirostris STIMPSON, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 44 [113].
Penaeus curvirostris KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 23, pl. VI, fig. 4; pl. VII, figs. 10, 10a, 10b, 10c.

Hakodate, Hokkaido; Aomori, Rikuoku; Nagasaki, Hizen.

PARAPENÆUS LAMELLATUS (de Haan).

Penaeus lamellatus DE HAAN, Fauna Japon., Crust., 1849, p. 193, pl. XLVI, figs. 4, 5.—KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 25, pl. VI, fig. 1; pl. VII, fig. 12.

Nagasaki, Hizen; 1 female.

PARAPENÆUS AKAYEBI, new species.

Penæus velutinus BATE, Challenger Rept., XXIV, 1888, p. 253 (part). Not *P. velutinus* Dana.

Penaeus velutinus KISHINOUYE, Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 26, pl. VI, fig. 2; pl. VII, figs. 11, 11*a*, 11*b*.

I think that this species can not be Dana's *P. velutinus*, as the maxillipeds are much shorter and the lateral spines of the telson are very large. Our species, however, coincides with some of the *Challenger* specimens collected in 8 fathoms in Japanese waters, labeled *P. velutinus* by Bate, and presented to the U. S. National Museum. The Japanese form is not that figured by Bate (pl. XXXIII, fig. 1). His remarks[a] indicate that he combined a number of species under the name *velutinus*.

Kishinouye[b] mentions, without description, the occurrence in Japan of some species very closely allied to that which he calls *Penaeus velutinus;* there is one such species (see below) in the Jordan and Snyder collection, and two others in the U. S. National Museum. The four species agree in their pubescence, in the lack of a carina on the carapace behind the gastric spine, and in the long lateral spines of the telson.

In *Parapenæus akayebi* (=*Penaeus velutinus* Kishinouye), the rostrum is horizontal or nearly so, and in adults extends to the end or beyond the end of the second segment of the antennula. Dorsal spines 7 or 8, the posterior spine situated a little in front of the anterior third of the carapace (rostrum excluded). A pair of ventral spines between the bases of the feet of the second pair. The sixth and seventh pleonic segments are elongate: the sixth segment is about three-fourths the length of the carapace.

Dimensions.—Female, length 87.9 mm., length of carapace and rostrum 31.1 mm., length of carapace 17.5 mm., length of sixth pleonic segment, on median line, 14 mm.

Localities. Wakanoura, Kii (3 males, 1 female); Onomichi, Bingo (1 female); Kawatana (1 female); Nagasaki, Hizen (4 males, 1 female); Jordan and Snyder coll. Japan; R. Hitchcock, coll. (1 male, 6 females; types, Cat. No. 26152), Mogi; Dr. F. C. Dale, U. S. N., U. S. S. *Palos*, collector.

This species, according to Dr. Kishinouye, is known in Japan as "akayebi."

PARAPENÆUS MOGIENSIS, new species.

The rostrum is straight, inclined slightly upward and does not extend quite to the end of the second antennular segment. Dorsal

[a] Challenger Report, XXIV, 1888, p. 256.

[b] Jour. Fish. Bureau, Tokyo, VIII, 1900, p. 27.

spines 8 or 9, the posterior one situated at the anterior fourth of the carapace, or further forward than in *P. akayebi.* Ventral spines between the bases of the feet of the second pair rudimentary. The sixth and seventh pleonic segments are shorter than in *P. akayebi;* the sixth segment is about three-fifths as long as the carapace; the seventh a little longer than the sixth. The thelycum and petasma are distinctive; the right branch of the latter is very broad at the end; the left branch is pointed at the end, and bears a few subterminal denticles.

FIG. 6.—PARAPENÆUS MOGIENSIS, FEMALE, × 1⅗: *a*, CARAPACE; *b*, SIXTH SEGMENT OF ABDOMEN.

FIG. 7.—PARAPENÆUS MOGIENSIS, PETASMA, VENTRAL VIEW, × 4½.

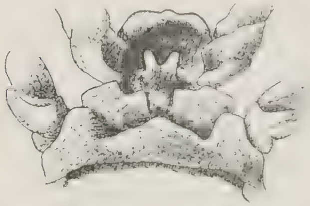

FIG. 8.—PARAPENÆUS MOGIENSIS, THELYCUM, × 4½.

Dimensions.—Female, length 80.7 mm., length of carapace and rostrum 29 mm., length of carapace 18.1 mm., length of sixth pleonic segment, measured on median line, 11.4 mm.

Type locality.—Mogi, Japan (with the preceding); Dr. F. C. Dale, U. S. N., U. S. S. *Palos*, June 18, 1881; 2 males, 5 females. (Cat. No. 26153.)

PARAPENÆUS DALEI, new species.

The rostrum is nearly horizontal, slightly convex or straight, and does not extend beyond the middle of the second antennular segment. The dorsal spines are 7 (exceptionally 8), the posterior one at the anterior fourth of the carapace. A pair of ventral spines between the bases of the feet of the second pair. The sixth pleonic segment is longer than in *P. mogiensis*, but not so long as in *P. akayebi;* it is about two-thirds as long as the carapace. The left branch of the petasma has a much more slender tip than in *P. mogiensis*, and the subterminal denticles are larger.

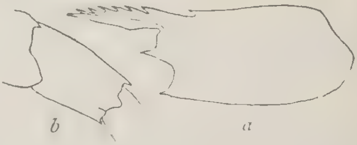

FIG. 9.—PARAPENÆUS DALEI, FEMALE, × 1⅗; *a*, CARAPACE; *b*, SIXTH SEGMENT OF ABDOMEN.

FIG. 10.—PARAPENÆUS DALEI, PETASMA, VENTRAL VIEW, × 4½.

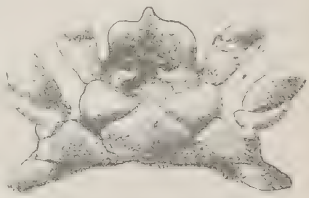

FIG. 11.—PARAPENÆUS DALEI THELYCUM, × 6⅔.

Dimensions.—Female, length 57 mm., length of carapace and rostrum 19 mm., length of carapace 12.5 mm., length of sixth pleonic segment, measured on median line, 7.9 mm.

Localities.—Six males and six females were taken at Mogi, with the two preceding species, by Dr. F. C. Dale, U. S. N., U. S. S. *Palos*, June 18, 1881; types (Cat. No. 26154). A somewhat larger male, of which the rostrum and the abdomen behind the third segment are lacking, was captured at Hakodate, Hokkaido, by Dr. Jordan and Mr. Snyder.

PARAPENÆUS ACCLIVIS, new species.

Rostrum ascending, reaching the end or a little beyond the end of the second antennular segment. Dorsal spines 8 or 9, the posterior

FIG. 12.—PARAPENÆUS ACCLIVIS, FEMALE, × 1⅔; *a*, CARAPACE; *b*, SIXTH SEGMENT OF ABDOMEN.

spine at the anterior fourth of the carapace. A pair of ventral spines between the bases of the feet of the second pair. The sixth pleonic segment is about seven-tenths as long as the carapace, and a little shorter than the seventh. The petasma is most nearly related to that of *P. akayebi*.

FIG. 13.—PARAPENÆUS ACCLIVIS, THELYCUM, × 3⅓.

FIG. 14.—PARAPENÆUS ACCLIVIS, PETASMA, VENTRAL VIEW, × 3⅓.

Dimensions.—Female, length 85.4 mm., length of carapace and rostrum 30 mm., length of carapace 18 mm., length of sixth pleonic segment, measured on median line, 13 mm.

Type locality.—Mogi, Japan; Dr. F. C. Dale, U. S. N., U. S. S. *Palos*, June 18, 1881; 3 males, 2 females. (Cat. No. 26155.)

SICYONIA CRISTATA (de Haan).

Hippolyte cristatus DE HAAN, Fauna Japon., Crust., pl. XLV, fig. 10. (Specific name corrected in text.)
Sicyonia cristata DE HAAN, Fauna Japon., Crust., 1849, p. 194.

Nagasaki, Hizen. Mogi (Dr. F. C. Dale).

Dorsal spines 7 or 8 (4 on the carapace proper); apex of rostrum tridentate.

SOLENOCERA DISTINCTA (de Haan).

Penaeus distinctus DE HAAN, Fauna Japon., Crust., 1849, p. 194.
Solenocera distincta MIERS, Proc. Zool. Soc. London, 1878, p. 302; 1879, p. 22.—KOEBEL, SB. Ak. Wien, XC, Pt. 1, 1884, p. 314, pl. II, figs. 1-7.

Wakanoura, Kii; one specimen.

Family CRANGONIDÆ.

CRANGON CRANGON (Linnæus).

Cancer crangon LINNÆUS, Syst. Nat., 10th ed., 1, 1758, p. 632.
Crangon vulgaris FABRICIUS, Suppl. Entom. Syst., 1798, p. 410.
Crangon crangon ORTMANN, Proc. Acad. Nat. Sci. Phila., 1895, p. 179 (not synonymy).

Same, Rikuoku; Jordan and Snyder; one specimen. Hakodate, Hokkaido; U. S. Fish Commission steamer *Albatross*, several specimens.

I have separated from *C. crangon* of Europe the form occurring in America (Atlantic and Alaskan coasts) under the name *C. septemspinosa* Say, on account of the antennal scale being narrower at the distal end, this margin sloping backward toward the inner end, instead of forward as in *C. crangon;* the spine of the scale is also proportionally longer in *C. septemspinosa*, equaling or exceeding the distal width of the blade, while in *C. crangon* the spine is usually shorter than the distal width of the blade.

Japanese specimens resemble the European rather than the American species. The scale is about two-thirds as long as the carapace (rostrum excluded). The length of the palms of the chelipeds varies from 2.4 to 2.8 times the width.

CRANGON PROPINQÚUS Stimpson.

Crangon propinquus STIMPSON, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 25 [94].

Aomori, Rikuoku; 4 specimens.

Rostrum narrow, exceeding the eyes, slightly spatulate. Scale measured on outer margin about five-sixths as long as carapace, exclusive of rostrum; spine more advanced than the blade. The palms of the chelæ are about 3½ times as long as wide, and the distal margin against which the dactylus folds, is directed obliquely at an angle of about 45 degrees. The third and fourth segments of the pleon are bluntly carinate. The telson is nearly as long as the carapace (rostrum excluded). The sixth segment and the telson are flattened above, and incompletely and indistinctly sulcate.

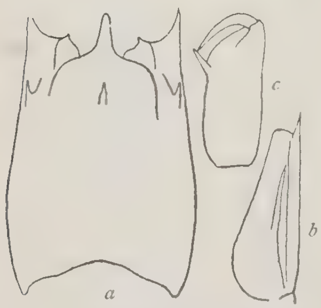

FIG. 15.—CRANGON HAKODATEI; *a*, CARAPACE, ×2⅗; *b*, ACICLE, ×3⅛; *c*, CHELIPED, ×3½.

CRANGON HAKODATEI, new species.

Dorsal surface pubescent, except on the abdominal carinæ. One median gastric spine. Rostrum not exceeding the eyes, gradually tapering, tip rounding. Scale (measured on outer margin) four-fifths as long as carapace, exclusive of rostrum; spine projecting beyond the blade as far as the

distal width of the blade. The outer maxillipeds reach to the extremity of the acicular spine. Palms of chelipeds 2½ times as long as wide; distal margin, against which the dactylus folds, inclined at about 45 degrees to the side margins. Abdomen furnished on the third, fourth, and fifth segments, with a high, blunt, naked, median carina; sixth and seventh segments with a shallow median sulcus.

Dimensions.—Female, length of body from tip of rostrum to tip of telson 44.5 mm., length of carapace from tip of rostrum 12.2 mm., length of scale (outer margin) 7.5 mm., length of palm of chela 5.5 mm.

Type locality.—Hakodate, Hokkaido; 8 specimens (Cat. No. 26156).

Family ALPHEIDÆ.

ALPHEUS RAPAX Fabricius?, Coutière.

?*Alpheus rapax* Fabricius, Suppl. Entom. System., 1798, p. 405.

Alpheus brevicristatus de Haan, Fauna Japon., Crust., pl. xlv, fig. 1. (Specific name corrected in text.)

Alpheus malabaricus de Haan, Fauna Japon., Crust., 1849, p. 177.

Alpheus rapax Coutière, Ann. Sci. Nat. (8), Zool., IX, 1899, p. 14.

Tokyo (1); Misaki, Sagami (3); Nagasaki, Hizen (2 specimens).

ALPHEUS BREVIROSTRIS (Olivier).

Palæmon brevirostris Olivier, Encyc. Méth., Hist. Nat., Entom., VIII, 1811, p. 664; Tabl. Encyc. Méth., 1818, pl. cccxix, fig. 4.

Alpheus rapax de Haan, Fauna Japon., Crust., 1849, p. 177, pl. xlv, fig. 2. Not *A. rapax* Fabricius.

Alpheus digitalis de Haan, Fauna Japon., p. 178, pl. xlv, fig. 4.

Alpheus brevirostris Coutière, Ann. Sci. Nat. (8), Zool., IX, 1899, p. 14.

Wakanoura, Kii; Onomichi, Bingo; Nagasaki, Hizen. A good series.

Family HIPPOLYTIDÆ.

SPIRONTOCARIS MORORANI, new species.

Very close to *S. dalli* Rathbun. Differs as follows: The dorsal carina is armed with 4 equal larger spines (instead of 3), of which 3 are on the carapace proper and one over the base of the eye; remainder of the rostrum furnished with 10 small spines above and 4 spines below, of which one is near the tip and makes it appear bifid. The rostrum is a little shorter than in *S. dalli*, reaching half way between the end of the antennular peduncle and the end of the antennal scale. Of the two supraorbital spines one is situated well behind the other; the anterior is nearly as strong as the posterior. The basal scale of the antennula reaches just to the end of the second segment. The antennal scale is narrower at the end than in *S. dalli*; the laminar portion is separated by a deep narrow slit from the spine. The outer maxilliped extended

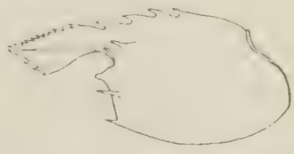

Fig. 16.—Spirontocaris mororani, carapace of female. ×2⅔.

reaches just to the end of the acicle: it is furnished with exopod and epipod; also the first three feet with epipods, as in *S. dalli*. Dactyli of last three feet longer than in *S. dalli*, being more than one-fourth the length of their respective propodi. The sixth segment of the abdomen is much shorter than in *S. dalli*, being less than half the length of the carapace (rostrum excluded).

Dimensions.—Female, length 33.5 mm., length of carapace and rostrum 11.8 mm., of rostrum 5.1 mm.

Type locality.—Mororan, Hokkaido; 1 female (Cat. No. 26157).

SPIRONTOCARIS JORDANI, new species.

Near *S. rectirostris* (Stimpson) of which I have at hand one specimen from Fusan, Korea (P. L. Jouy, collector, 1885), and one specimen from Hakodate Bay, Japan, 11½ fathoms (station 3656, U. S. Fish Commission steamer *Albatross*).

In *S. jordani* the rostrum extends barely to the end of the antennal peduncle, nearly straight and horizontal, slightly convex above, narrow, of about even width throughout, armed with 8 spines above, of which 2 are behind the orbit, and 1 beneath, subterminal; the posterior spine is situated at the anterior fifth of the carapace; at its posterior base there is a rudiment of another spine. As in *S. rectirostris* there is no supraorbital, an antennal, a very small pterygostomian spine. The antennular scale reaches to the end of the second antennular segment; the antennular peduncle to the middle of the antennal scale; this scale is very broad at its extremity, the blade exceeds the spine. The outer maxillipeds overreach the scale by half the length of the last segment. They are destitute of an exopod, but are provided with an epipod, as are also the first three pairs of feet. The third pair of feet overreach a little the first pair, their dactyli are one-fourth as long as their propodi. The sixth segment of the abdomen is three-fifths as long as the carapace (rostrum excluded). Telson as long as the inner uropod, much shorter than the outer one.

Fig. 17.—Spirontocaris jordani, carapace of female, × 2⅔.

Dimensions.—Female, length 46.5 mm., length of carapace and rostrum 13.2 mm., of rostrum 5 mm.

Type locality.—Hakodate, Hokkaido; 1 female (Cat. No. 26158).

SPIRONTOCARIS GREBNITZKII, new species.

Near *S. stylus* (Stimpson), but stouter. Rostrum nearly as long as the rest of the carapace, reaching to end of antennal scale, straight, acute. Dorsal carina arising at the middle of the carapace, armed with 8 equal and equidistant spines, 2 of which are behind the orbit, the posterior one at the anterior fifth of the carapace, the anterior spine just before the middle of the rostrum. Lower margin armed

with 2 or 3 spines, the posterior of which is just anterior to the distal of the superior spines. A strong antennal, a minute pterygostomian spine. Eyes very small. Antennular peduncle falling short of the middle of the antennal scale; basal scale of antennula reaching about to middle of second segment. Antennal scale three fourths as long as carapace; blade much exceeding spine. The maxillipeds reach just to end of scale, are devoid of an exopod, but provided with an epipod, as are the first three pereiopods. The sixth segment of the abdomen is a little more than half as long as the carapace. The telson is shorter than the subequal uropods, and is armed with 4 pairs of lateral spinules.

FIG. 18.—SPIRONTOCARIS GREBNITZKII, CARAPACE OF FEMALE, × 1⅗.

Dimensions.—Female, length 54.5 mm., length of carapace and rostrum 18.5 mm., of rostrum 8.7 mm.

Type locality.—One specimen was secured by Dr. Jordan and Mr. Snyder at Mororan, Hokkaido, but as it is imperfect, I have taker for the type another from the same locality collected a few years ago by N. Grebnitzki (Cat. No. 26159).

SPIRONTOCARIS GENICULATA (Stimpson).

Hippolyte geniculata STIMPSON, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 34 [103].

Mororan, Hokkaido; Jordan and Snyder; 6 small.

Miura, Atami District, March, 1890; F. Sakamoto; 2 females with ova. Called "Kushakoshi ebi or grass-belt shrimp."

Rostrum longer than the carapace (measured on median line from posterior margin to line of orbits), not quite reaching tip of antennal scale, straight, horizontal, acuminate, armed with 4 or 5 teeth above, 1 or 2 of which are behind the orbit, and 5 to 8 teeth below, 1 or 2 of which may be subterminal. A strong antennal, no supraorbital nor pterygostomian spine. The antennular peduncle reaches abou one-third the length of the acicle; its basal scale extends a little beyond first segment. The antennal peduncle reaches to end of second segment of antennular peduncle; the acicle is a little longer than the carapace, extremity very oblique, blade exceeding by far the spine. The outer maxillipeds and the fifth pair of pereiopods reach just to the end of the antennular peduncle; the second pair of pereiopods to the middle of the acicle. The maxillipeds have an epipod but no exopod; the pereiopods are destitute of epipods.

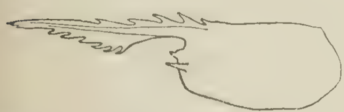

FIG. 19.—SPIRONTOCARIS GENICULATA, CARAPACE OF FEMALE, × 1⅗.

The abdomen is bent at a right angle at the third segment; in profile the angle is rounded; the posterior part of the third segment is strongly compressed. This compression and angulation is very well marked in the adult females from Miura, much less so in the specimens,

two-thirds the size, from Mororan. The sixth segment is three-fifths as long as the carapace, and four-fifths as long as the telson. Telson shorter than uropods, of which the inner is shorter than the outer; lateral spines 3 or 4.

Dimensions.—Female with ova: Length 60.1 mm., length of carapace and rostrum 21.8 mm., length of rostrum 11.4 mm.

PLATYBEMA PLANIROSTRE (de Haan).

Lysmata planirostris DE HAAN, Fauna Japon., Crust., pl. O.[a]
Hippolyte planirostris DE HAAN, Fauna Japon., Crust., pl. XLV, fig. 7.[a]
Cyclorhynchus planirostris DE HAAN, Fauna Japon., Crust., 1849, p. 175.
Rhynchocyclus planirostris STIMPSON, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 27 [96].—MIERS, Proc. Zool. Soc. London, 1879, p. 55.
Rhynchocyclus mucronatus STIMPSON, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 28 [96].
Platybema planirostris BATE, Challenger Macrura, 1888, p. 578.

Hakodate, Hokkaido; 2 females with ova.

In both these specimens the posterior median spine is rudimentary, being present in the shape of a smooth rounded lobe. In the only specimen provided with a rostrum, the teeth above the point number 15, those below 12. Anterior margin of carapace behind the antennæ armed with about 9 pectinated spines. Antennal flagellum nearly as long as body. The carpus of the first pair of feet is not carinate above, and is provided with a tooth at the upper distal end. Carpus of second pair triarticulate, first and third articles equal, both together nearly as long as second.

Family PANDALIDÆ.

PANDALUS HYPSINOTUS Brandt.

Pandalus hypsinotus BRANDT, in Middendorff's Reise in den äussersten Norden und Osten Sibiriens, II, Zool., I, 1851, p. 125.

Mororan, Hokkaido; one young specimen about 25 mm. long. This locality is an extension of the range, the species having a distribution from Bering Sea southward, on the one hand to the Straits of Fuca and on the other to the Kurile Islands.

A figure will be given in the forthcoming report on the Decapoda of the Harriman Expedition.

PANDALUS LATIROSTRIS, new species.

Carapace and rostrum as long as the abdomen, lacking one-fourth of the telson. Rostrum one-third longer than the carapace, basal half horizontal, terminal half slightly ascending, broad at base, gradually tapering, a prominent smooth lateral carina. Dorsal carina arising at the middle of the carapace, armed with a series of 16 to 18 movable spines, of which 4 or 5 are behind the orbit, the posterior spine at

[a] Generic name changed in Errata.

about the anterior sixth of the carapace, anterior spine near the middle of the rostrum; in addition, there is one subterminal immovable spine, occasionally two. Extremity of rostrum spiniform. Lower limb rather deep in front of the eye, gradually diminishing anteriorly, armed with 10 to 13 immovable spines. Antennal spine strong; pterygostomian spine much smaller, but well marked. Eyes of moderate size, corneæ dilated, reddish brown in alcohol.

Peduncle of antennules reaching about one-third the length of the antennal scale; basal scale half as long as first segment, second segment about one-third longer than third. Outer flagellum reaches to

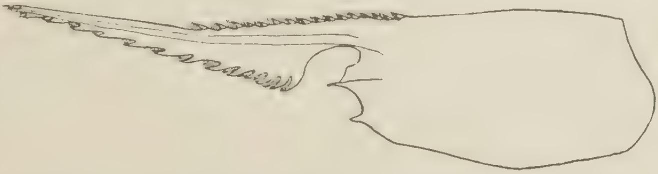

FIG. 20.—PANDALUS LATIROSTRIS, CARAPACE, SIDE VIEW, × 1⅓.

the end of antennal scale, slender terminal portion two-fifths as long as thickened basal portion; inner flagellum one-half longer than outer. Peduncle of antennæ reaching just to the end of the second segment of the antennular peduncle, the scale reaches not quite to the end of the rostrum, the end of the blade is very obliquely rounded and overreaches considerably the outer spine; the flagellum is as long as the body, exclusive of the telson.

The outer maxillipeds reach only to the middle of the antennal scale, and are rather stout; the first pair of feet reach to the middle of the last joint of the maxillipeds. Of the second pair, the right

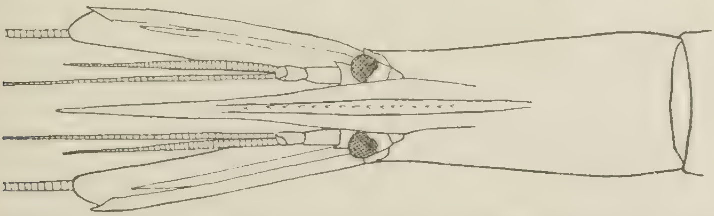

FIG. 21.—PANDALUS LATIROSTRIS, CARAPACE AND ANTENNÆ, DORSAL VIEW, × 1⅓.

foot is stouter and shorter, reaching as far as the first pair; the left foot exceeds the maxilliped by the length of the chela and half the last carpal joint, and exceeds the third pair but little; the fourth and fifth pairs are successively shorter than the third, and nearer the same length than the third and fourth; the dactyli are contained a little more than three times in their propodi; the latter are not essentially different in the sexes.

The abdomen is smooth; the third segment is very little produced over the fourth. The infero-posterior angle of the fourth, fifth, and sixth segments is armed with a spine. Sixth segment twice as long as wide, and two-thirds as long as the telson, which is armed with 5

or 6 spinules on each side. The telson may be a little longer or shorter than the inner uropods; the outer uropods longer than the inner.

Dimensions.—Female, length 127 mm., length of carapace and rostrum 60.5 mm., length of rostrum 34.5 mm.

Localities.—Mororan, Hokkaido; Jordan and Snyder; 18 specimens, males and females, types (Cat. No. 26160). Two specimens were collected previously at the same place by N. Grebnitzki. Tokyo, 1 young; Jordan and Snyder.

In four instances the acicle on one side is a little longer than that on the other, though both are regular in shape.

PANDALOPSIS MITSUKURII, new species.

Slender. Carapace as long as the abdomen, lacking half the telson. Rostrum one and two-thirds times as long as the rest of the carapace,

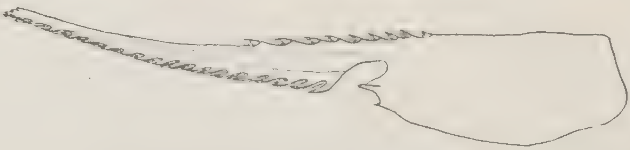

FIG. 22.—PANDALOPSIS MITSUKURII, CARAPACE, SIDE VIEW, × $1\frac{2}{3}$.

basal half horizontal, terminal half slightly ascending, slender. Dorsal carina blunt, armed with 8 to 10 movable spines, of which 2 or 3 are behind the orbit, the posterior spine at the anterior fifth of the carapace, and marking the end of the carina; anterior spine but little in front of the posterior third of the rostrum; ventral spines 13 to 18, becoming distally very small and appressed; tip of rostrum trifid. Antennal spine strong, the margin of the carapace retreating rapidly from that point; pterygostomian spine two-thirds as large. Eyes small, corneæ little dilated, of a dark bluish-gray color in alcohol, a small black ocellus behind the corneal margin and on the upper outer surface.

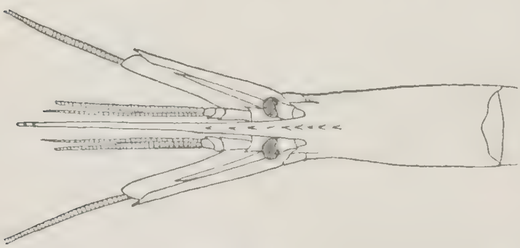

FIG. 23.—PANDALOPSIS MITSUKURII, CARAPACE AND ANTENNÆ, DORSAL VIEW, × $1\frac{1}{3}$.

The peduncle of the antennules reaches about two-fifths the length of the antennal scale; second segment nearly twice as long as third; basal scale small, reaching only to middle of cornea; inner flagellum a little longer than outer and barely attaining the end of the rostrum. Peduncle of antennæ reaching to the middle of second antennular segment; the flagellum may equal the length of the body, excluding the telson. The scale extends to about the distal third of the rostrum, oblong, very little tapering, extremity of blade oblique, projecting beyond the spine.

The outer maxillipeds are rather stout, and when extended lie along three-fifths of the antennal scale; the antepenult segment has a narrow laminar expansion below. The first pair of feet attain the end of the penultimate joint of the maxilliped; the merus joint has the expansion characteristic of the genus. The feet of the second pair are equal, carpus 11 or 12 jointed, the proximal and the distal joint elongate, the intermediate joints short and subequal; the chelæ exceed the maxillipeds by the length of the fingers. The third pair reach scarcely beyond the second pair; the fourth and fifth pairs are much shorter and there is little difference in their length; the fifth pair reaches as far as the first pair; the propodi are three times as long as the dactyli in the third pair, four times as long in the fifth pair, intermediate in the fourth pair.

The abdomen is strongly bent at the third segment, which is laterally compressed, forming a rounded carina. The fourth, fifth, and sixth segments are armed with a postero-inferior spine. Sixth segment three-fifths as long as carapace and four-fifths as long as telson, the latter armed with 4 or 5 spinules on each side. Telson a little shorter than the uropods, of which the inner pair are shorter than the outer.

Dimensions.—Female: Length 105 mm., length of carapace and rostrum 45 mm., length of rostrum 28.1 mm.

Type locality. Mororan, Hokkaido; Jordan and Snyder; 55 specimens, types (Cat. No. 26161). Two specimens had been taken previously at the same locality by N. Grebnitzki.

The specific name is given in honor of Prof. K. Mitsukuri, of the University of Tokyo.

Family ATYIDÆ.

XIPHOCARIS COMPRESSA (de Haan).

? *Ephyra compressa* DE HAAN, Fauna Japon., Crust., 1849, p. 186, pl. XLVI, fig. 7.
Xiphocaris compressa ORTMANN, Proc. Acad. Nat. Sci. Phila., 1894, p. 400, and synonymy.

Lake Biwa, Matsubara, Omi; many specimens about 1 inch long; Jordan and Snyder.

Tsushima Island, Japan; P. L. Jouy, May, 1885, 1 female with ova.

Near Fusan, Korea, in fresh-water streams; P. L. Jouy, 1 specimen.

CARIDINA DENTICULATA de Haan.

Hippolyte denticulatus DE HAAN, Fauna Japon., Crust., pl. XLV, fig. 8. (Generic name changed in text.)
Caridina denticulata DE HAAN, Fauna Japon., Crust., 1849, p. 186.—ORTMANN, Proc. Acad. Nat. Sci. Phila., 1894, p. 406.

The rostrum extends either to the middle of the third antennular segment, to the end of that segment, or even beyond it. The dorsal

spines are 14 to 18, 3 or 4 behind the orbit, ventral spines 4 to 6, terminal third of rostrum unarmed. The maxillipeds reach nearly to the end of the antennular peduncle, the first pair of feet not quite to the end of antennal peduncle; the carpus is about one and a half times as long as wide, longer than the palm of the hand; the fingers longer than the palm. The second pair of feet reach to the end of the antennal peduncle; carpus and propodus subequal in length, palm enlarged distally, shorter than the fingers. The propodus of the fifth pair of feet is three times as long as the dactylus.

A female with ova measures 22.8 mm. long; the eggs are 0.9 mm. long.

Kurume, Japan; Jordan and Snyder, July 23; 1 female with ova. Near Fusan, Korea, in fresh-water streams; P. L. Jouy; many specimens.

This species is very close to, perhaps identical with, *C. pareparensis* de Man,[a] from Celebes, which has a shorter rostrum, with only 2 inferior teeth.

CARIDINA LEUCOSTICTA Stimpson.

Caridina leucosticta Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 28 [97].—Ortmann, Proc. Acad. Nat. Sci. Phila., 1894, p. 406.
Atya wyckii Hickson, Ann. Mag. Nat. Hist. (6), II, 1888, p. 357, pls. XIII and XIV.
Caridina wycki Ortmann, Proc. Acad. Nat. Sci. Phila., 1894, p. 405, and synonymy.

Kurume, July 23; about 25 specimens.

In most of the specimens the rostrum is broken off near its base; in none is the tip perfect.

Dorsal spines 17 to 23 (2 on carapace); ventral spines 14 in the only specimen where complete (Stimpson says 10). Anterior third or fourth unarmed above, except near the tip, where there is at least one spine. Antennal spine high, quite above the antenna. The color and white spots described by Stimpson are not visible in the preserved specimens.

Family PALÆMONIDÆ.

PALÆMON JAPONICUS (Ortmann).

Leander longirostris var. *japonicus* Ortmann, Zool. Jahrb., Syst., V, 1891, p. 519, pl. XXXVII, figs. 14, 14z.

Matsushima, Rikuzen; Enoshima, Sagami; Kawatana; Nagasaki, Hizen.

The reference of the name *Palæmon longirostris* to Say by Milne Edwards,[b] and later by de Man[c] and Ortmann,[d] is founded on a clerical error. Say[e] described only two species of *Palæmon*, both Ameri-

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[a] Weber's Zool. Ergeb. Reise Niederl. Ost-Indien, II, 1892, p. 379, pl. XXII, fig. 25.
[b] Hist. Nat. Crust., II, 1837, p. 394.
[c] Notes Leyden Mus., III, 1881, p. 141.
[d] Zool. Jahrb., Syst., V, 1891, p. 519.
[e] Jour. Acad. Nat. Sci. Phila., I, 1818.

can, viz, *P. vulgaris* on page 248, and *P. tenuicornis* on page 249. Milne Edwards[a] refers to both of Say's species, to *P. vulgaris* on page 394, and to "*Palémon tenuirostre*" on page 395, but his footnote references "(2)" and "(3)" to Say's descriptions, instead of being placed correctly in the text, i. e., (2) after *P. vulgaris* and (3) after *P. tenuirostre*, are made dependent, (2) on *P. longirostris* and (3) on *P. vulgaris*. The name *P. longirostris* Milne Edwards, occurring on p. 394, was changed by him in Errata, vol. III, p. 638, 1840, to *P. styliferus*, a name apparently overlooked by subsequent authors, but which must stand for that species. The name *P. longirostris* should be used for the species so designated by Milne Edwards on p. 392 (= *P. edwardsii* Heller).

Ortmann[b] makes *P. japonicus* a variety of *P. styliferus*, but it is distinguished as follows: *P. japonicus* has no dorsal spines on the rostrum except at the base, while *P. styliferus* has 2 or 3 on the terminal half. *P. japonicus* has 4 to 6 ventral spines, *P. styliferus* 8 to 10. In *P. japonicus* the sixth segment of the pleon is nearly two-thirds as long as the carapace (rostrum excluded); in *P. styliferus* it is shorter, barely more than half the carapace. In *P. japonicus* the carpus of the second pair of feet is as long as the merus or the fingers, while in *P. styliferus* the carpus is considerably shorter than merus or fingers.

There are in the U. S. National Museum a number of specimens of *P. styliferus* from Kurrachee, India, collected by Francis Day.

PALÆMON PAUCIDENS de Haan.

Palemon paucidens de HAAN, Fauna Japon., Crust., 1849, p. 170, pl. XLV, fig. 11.
Leander paucidens STIMPSON, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 40 [109].

Aomori, Rikuoku; Matsushima, Rikuzen; Misaki, Sagami; Lake Biwa, Matsubara, Omi (abundant); Kawatana; Kurume; Nagasaki, Hizen.

Korea, P. L. Jouy coll.: Fusan; Gensan, brackish streams flowing into the sea.

The rostrum has 5 to 6 teeth above (1 on carapace), 2 to 3 below, and is usually bifid at extremity; it extends about to the end of the acicle. The branches of the outer flagellum of the antennulæ are joined for about 8 segments or less than half of the length of the shorter branch. In fully developed specimens the outer maxillipeds may or may not exceed the antennal peduncle, and the carpus of the second pair of feet usually exceeds the acicle.

Dimensions.—A large female measures 66.5 mm. long. Several hundred specimens were taken at Lake Biwa, all smaller than those from salt water; a female with ova measures 38 mm. Stimpson[c] records its occurrence in fresh water, in rivers near Simoda.

[a] Hist. Nat. Crust., II, 1837.
[b] Zool. Jahrb., Syst., V, 1891, p. 519.
[c] Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 40 [109].

PALÆMON SERRIFER (Stimpson).

Leander serrifer STIMPSON, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 41 [110].—DE MAN, Notes Leyden Mus., III, 1881, p. 139.—ORTMANN, Zool. Jahrb., Syst., V, 1891, p. 525, pl. XXXVII, fig. 17.

Misaki, Sagami; Jordan and Snyder collection. Atami district; F. Sakamoto collector, April, 1894.

Out of 21 specimens with perfect rostrum, 7 have 9 teeth above, the remainder mostly 10 teeth above; 15 have 3 teeth below, the remainder varying from 2 to 5 teeth.

PALÆMON MACRODACTYLUS, new species.

Stout. Rostrum about as long as carapace, it may be a little longer or a little shorter, overreaching a little the antennal scale; straight in basal half, slightly inclined upward in distal half; armed above with 9 to 15 teeth, 3 of which are on the carapace, 3 to 5 below, tip usually bifid; posterior dorsal tooth more remote from the others; the anterior tooth may be remote from the others or remote from the tip. Only large specimens have 13 to 15 teeth above; the usual number is 10 to 12. Antennular peduncle reaching to distal fourth of scale; antennal peduncle to end of first antennular segment. Filaments of outer flagellum of antennula united for from 7 to 9 joints; short filament much longer than the basal portion. Acicle oblong, very broad at extremity.

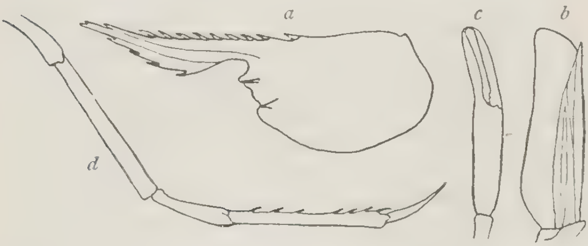

FIG. 24.—PALÆMON MACRODACTYLUS; *a*, CARAPACE, × 1⅗; *b*, ACICLE, × 2⅗; *c*, CHELA OF SECOND PAIR, × 2⅗; *d*, FOOT OF THIRD PAIR, × 3⅕.

Outer maxillipeds reaching beyond antennal peduncle by at least two-thirds of the last segment. The first pair of feet, extended, touch the end of the scale; the carpus is one and two-thirds times as long as the chela; the palm is a little longer than the fingers. The second pair of feet may exceed the scale by the length of the chela and part of the wrist. The carpus is subequal to the merus, exceeds the manus in length, and is distally enlarged. Palm compressed, broader than carpus, longer than fingers. The last three pairs of legs are very nearly of a length, the fifth pair attain the end of the scale; the dactyli of the third pair are contained twice or two and a half times, of the fifth pair about three times, in their propodi.

The sixth segment of the abdomen is half as long as the carapace (rostrum excluded), and three-fourths as long as the telson, which has two pairs of lateral spinules, and at the extremity a short median and lateral spine and a very long intermediate spine.

Dimensions. Female with ova: Length, 55 mm.; length of carapace and rostrum, 23.7 mm.; length of rostrum, 12.7 mm.

Localities.—Aomori, Rikuoku (type locality, Cat. No. 26162); Matsushima, Rikuzen; Nagasaki, Hizen. Also collected by P. L. Jouy in Korea, at Fusan, Gensan, and Chemulpo.

This species in appearance much resembles *P. serrifer*, but differs in having, as a rule, more rostral teeth, broader aciele, longer fingers of second chelipeds, longer dactyls of last three pairs. In the young the rostrum may be a little convex above, the palm and fingers of the second pair subequal.

PALÆMON PACIFICUS (Stimpson).

Leander pacificus Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, p. 40, [109].—De Man, Notes Leyden Mus., III, 1881, p. 137.

Rostrum extending beyond antennal scale for about one-third of its length, strongly upturned toward its extremity, armed with 7 to 8 teeth above (2 or 3 on carapace), 4 or 5 below, tip usually trifid.

The filaments of the outer flagellum of the antennulæ are united for from 10 to 12 joints; the free end of the short filament has 28 to 36 joints; its outer margin or that which fits against the longer filament is strongly serrate.

Otherwise this species is much as in *P. affinis* Milne Edwards.

Misaki, Sagami; Wakanoura, Kii; Nagasaki, Hizen.

BITHYNIS NIPPONENSIS (de Haan).

Palemon nipponensis de Haan, Fauna Japon., Crust., 1849, p. 171.
Palæmon nipponensis Ortmann, Zool. Jahrb., Syst., V, 1891, p. 713, pl. xlvii, figs. 4 and 4z, and synonymy.

Wakanoura, Kii; Chikugo River, Kurume, Chikugo; Kurume, July 23 (many specimens).

BITHYNIS LONGIPES (de Haan).

Palemon longipes [a] de Haan, Fauna Japon., Crust., 1849, p. 171.
Palæmon longipes Ortmann, Zool. Jahrb., Syst., V, 1891, p. 715.

Kawatana, July 22 (many specimens); Nagasaki, Hizen.

The two foregoing species are very closely related; they may be separated by the following characters, which are not absolutely constant:

In *B. nipponensis* the rostrum is usually nearly straight and bears 12 or 13 teeth above; in *B. longipes* it is usually more arched and has 10 or 11 teeth above.

In *B. nipponensis*, adult, the fingers of the second cheliped are

[a] I have given a new name, *Palæmon ortmanni*, to *P. longipes* (Ortmann) = *Leander longipes* Ortmann, not *P. longipes* de Haan. There is in the U. S. National Museum a specimen of *P. ortmanni* from Tsushima Island, Japan, collected by P. L. Jouy.

nearly as long as the palm, very hairy, the teeth at their base small and concealed in hair; in *B. longipes*, adult, the fingers are only one-half as long as the palm, very little or not at all hairy. There is one well-developed tooth near the base of the pollex and two either side of it near the base of the dactylus.

In *B. nipponensis*, young, the fingers are longer than the palm; in *B. longipes*, young, they are nearly as long as the palm.

Order STOMATOPODA.

ODONTODACTYLUS SCYLLARUS (Linnæus).

Cancer scyllarus Linnæus, Syst. Nat., 10th ed., I, 1758, p. 633.

Odontodactylus scyllarus Bigelow, Proc. U. S. Nat. Mus., XVII, 1894, p. 496, and synonymy.—Borradaile, Proc. Zool. Soc. London, 1898, p. 36, pl. v, fig. 6, and synonymy.

Wakanoura, Kii; one male.

The dactylus and distal end of propodus of the raptorial limb are bright red in the specimen preserved in alcohol.

LYSIOSQUILLA LATIFRONS (de Haan).

Squilla latifrons de Haan, Fauna Japon., Crust., 1849, p. 222, pl. li, fig. 3.

Lysiosquilla (*Coronis*) *latifrons* Miers, Ann. Mag. Nat. Hist. (5), V, 1880, p. 10.

Lysiosquilla latifrons Bigelow, Proc. U. S. Nat. Mus., XVII, 1894, p. 503.

Nagasaki, Hizen; one female.

Length from tip of rostrum to end of telson 64.4 mm.; length of carapace 14.5 mm.

The dactylus of the right raptorial limb in de Haan's figure has 6 teeth, of the left limb 7 teeth; in our specimen the dactyli of both limbs have 6 teeth.

The posterior margin of the telson is armed with 12 small spines on one side of the sinus, 11 spines on the other side.

CHLORIDELLA[a] FASCIATA (de Haan).

Squilla fasciata de Haan, Fauna Japon., Crust., 1849, p. 224, pl. li, fig. 4.—Miers, Ann. Mag. Nat. Hist., (5) V, 1880, p. 29.—Brooks, Challenger Rept., XVI, Stomatopoda, 1886, p. 37, pl. iii, figs. 4, 5; pl. ii, fig. 8.—Bigelow, Proc. U. S. Nat. Mus., XVII, 1894, p. 510.

Tsuruga, Echizen, 2 males; Nagasaki, Hizen, 1 male, 1 female.

The intermediate denticles of the margin of the telson are either 8 or 9.

The largest specimen measures 76.5 mm. long; carapace, 19 mm. long.

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[a] In 1899 (Jour. Inst. Jamaica, II, p. 628), I called attention to the fact that the name *Squilla* J. C. Fabricius, 1793, was preoccupied for a genus of Amphipoda by O. F. Müller, 1776 and 1788, by Scopoli, 1777, and by O. Fabricius, 1780. The only available name for the stomatopod genus is *Chloridella* Miers, 1880. One who considers *Chloridella* generically distinct from *Squilla* J. C. Fabricius should substitute a new name for the latter.

CHLORIDELLA RAPHIDEA (Fabricius).

Squilla harpax DE HAAN, Fauna Japon., Crust., 1849, p. 222, pl. LI, fig. 1.
Squilla raphidea BIGELOW, Proc. U. S. Nat. Mus., XVII, 1894, p. 535, and synonymy.

Wakanoura, Kii; 5 specimens.

CHLORIDELLA AFFINIS (Berthold).

Squilla oratoria DE HAAN, Fauna Japon., Crust., 1849, p. 223, pl. LI, fig. 2.
Squilla affinis BIGELOW, Proc. U. S. Nat. Mus., XVII, 1894, pp. 537 and 538, fig. 22, and synonymy.

Aomori, Rikuoku; Same, Rikuoku; Tokyo; Tsuruga, Echizen (abundant); Wakanoura, Kii (abundant); Onomichi, Bingo; Nagasaki, Hizen.

CHLORIDELLA COSTATA (de Haan).

Squilla costata DE HAAN, Fauna Japon., Crust., 1849, p. 223, pl. LI, fig. 5.—MIERS, Ann. Mag. Nat. Hist., (5), V, 1880, p. 21.—BIGELOW, Proc. U. S. Nat. Mus., XVII, 1894, p. 511.

Wakanoura, Kii, 2 specimens, male and female; Nagasaki, Hizen, 3 males.

The surface of the carapace is tuberculate, especially between the median and submedian carinæ, the tubercles more or less confluent. The marginal denticles of the telson are 3–4, 6–8, 1.

The largest specimen measures 87 mm. long; carapace, 22.5 mm. long.

A REVIEW OF THE HEMIBRANCHIATE FISHES OF JAPAN.

By David Starr Jordan and Edwin Chapin Starks,
Of the Leland Stanford Junior University

In the present paper is given a review of the Hemibranchiate fishes known to inhabit the waters of Japan. It is based on material in the Leland Stanford Junior University and in the U. S. National Museum, most of it collected by Jordan and Snyder in the summer of 1900. In a previous paper in these Proceedings[a] Mr. Starks has discussed the osteology of the suborder Hemibranchii and of its component families.

Order ACANTHOPTERGII.

Suborder HEMIBRANCHII.

Opisthotics absent; parietals usually absent; exoccipitals never meeting over surface of basioccipitals; myodome usually absent or rudimentary, sometimes well developed; posttemporal never typically forked, sometimes united to cranium suturely; a portion of the hypocoracoid sometimes enamelled, appearing externally as a separate bone on either side (interclavicle); supraclavicle usually absent, small when present; postclavicle when present composed of a single bone; superior pharyngeals and usually elements of branchial arches reduced in number; inferior pharyngeals present, not united; four anterior vertebræ more or less elongate, sometimes united; transverse process present on all abdominal vertebræ; snout more or less produced and tube-like with a small mouth at its end; ventrals abdominal, sometimes anteriorly placed. These fishes are allied to the *Percesoces*, from ancestors of which it is probably descended. Their relations to the Lophobranchii are close, the characters of the Lophobranchii being largely extremes of the same modifications.

(ἧμι, half; βράγχος, gill.)

In the following analysis of families we adopt the arrangement of families as given in Dr. Gill's valuable discussion of "The Mutual Relations of the Hemibranchiate Fishes."[b]

[a] Proc. U. S. Nat. Mus., XXV, 1902, p. 618.
[b] Proc. Acad. Nat. Sci. Phila., 1884, p. 154.

a. Dermal armature absent, or developed only as plates on side or back; vertebræ numerous (30 to 36); pubic bones placed close to scapular arch; spinous dorsal represented by isolated spines.

b. Vertebræ anteriorly little enlarged; ventrals subthoracic, each with a sharp spine.

c. Branchiostegal rays three; ventrals with one soft ray each; snout conic or but slightly tubiform.................................GASTEROSTEIDÆ, I.

cc. Branchiostegal rays four; ventrals with four soft rays each; snout tubiform..AULORHYNCHIDÆ, II.

bb. Vertebræ anteriorly (first four) elongate; ventrals abdominal or near middle of body, without spines, but with 6 (or 5) soft rays.

d. Dorsal spines developed, weak; body compressed, moderately long, with ctenoid scales; no caudal filament.....................AULOSTOMIDÆ, III.

dd. Dorsal spines undeveloped; body depressed or subcylindrical, very long without scales; caudal with the two middle rays produced into a long filament...FISTULARIIDÆ, IV.

aa. Dermal armature superficial, developed anteriorly and especially about the back; four anterior vertebræ much elongate; tail with its axis continuous with that of the abdomen; branchihyals and pharyngeals mostly present (fourth superior branchihyal and first and fourth superior pharyngeals wanting); pubic bones remote from the scapular arch; a spinous dorsal fin developed.
MACRORHAMPHOSIDÆ, V.

aaa. Dermal armature connate with the internal skeleton and developed as a dorsal cuirass in connection with the neuropophyses; six or more anterior vertebræ extremely elongate; tail with its axis deflected from that of the abdomen by encroachment of a dorsal cuirass over the dorsal fin; branchial system usually feebly developed; a spinous dorsal feebly developed under the posterior projection of the dorsal buckler ....CENTRISCIDÆ, VI.

Family I. GASTEROSTEIDAE.

STICKLEBACKS.

Body more or less fusiform, somewhat compressed, tapering behind to a slender caudal peduncle. Head moderate, the anterior part not greatly produced, but all the bones of the suspensory apparatus somewhat lengthened. Mouth moderate, with the cleft oblique, the lower jaw prominent; maxillary bent at right angles and overlapping the premaxillary at corner of mouth. Teeth sharp, even, in a narrow band in each jaw; no teeth on vomer or palatines; premaxillaries protractile. Preorbital rather broad; suborbital plate large, often covering the anterior part of the cheeks, forming a connection with the preopercle. Branchiostegals 3. Gill membranes broadly joined, free from the isthmus, or not; gill rakers moderate or rather long. Toothed superior pharyngeals 2; that of fourth arch missing or united to third. Opercles unarmed. Skin naked or with vertically oblong bony plates; no true scales. Dorsal fin preceded by two or more free spines; anal similar to soft dorsal, with a single spine; ventral fins abdominal, anteriorly placed and overlapped slightly at the side by a process from the shoulder girdle, though not connected to it, consisting of a stout spine and one or two rudimentary rays. Middle or sides of belly shielded by the pubic bones. Pectorals

rather short, unusually far behind the gill openings, preceded by a quadrate naked area, which is covered with shining skin. Caudal fin narrow, usually lunate. Air bladder simple; a few pyloric cœca. Vertebræ 30 to 35; anterior vertebræ little enlarged.

Small fishes inhabiting the fresh waters and arms of the sea in northern Europe and America; noted for their pugnacity. They are exceedingly destructive to the spawn and fry of large fishes.

a. Gill openings restricted, the membranes mesially united to the isthmus; dorsal with two free spines; skin mailed, partly mailed, or naked......*Gasterosteus*, 1.

aa. Gill openings confluent, the gill membranes forming a broad, free margin across the isthmus; dorsal spines 8 to 11, divergent; skin naked or mailed. *Pygosteus*, 2.

1. GASTEROSTEUS (Artedi) Linnæus.

Gasterosteus (ARTEDI) LINNÆUS, Syst. Nat., X, 1758, p. 489 (*aculeatus*).
Gasteracanthus PALLAS, Mem. Ac. St. Petersb., III, 1811, p. 325 (*cataphractus*).
Leiurus SWAINSON, Nat. Hist. Class'n Fishes, II, 1839, p. 242 (*gymnurus*).

Sticklebacks with the innominate bones coalescent on the median line of the belly, behind and between the ventral fins, forming a triangular or lanceolate plate. Gill membranes united to the isthmus. Tail slender, and usually keeled. Skin variously covered with bony plates. Dorsal spines 3 in number, strong, with nondivergent bases. Species numerous. Fresh waters and shores of all northern regions; the species highly variable, those found in the sea usually with the body completely mailed, the fresh and brackish water forms variously mailed or even altogether naked. It is probable that the reduction in armature is in some degree connected with life in fresh waters. It is almost certain that the partly naked forms are in each species derived from mailed forms of the same region.

(γαστήρ, belly; ὀστέον, bone.)

1. GASTEROSTEUS CATAPHRACTUS (Pallas).

TOGEUWO (PRICKLY-FISH).

Gasteracanthus cataphractus PALLAS, Mem. Acad. Petersb., III, 1811, p. 325; Kamchatka.

Gasterosteus obolarius CUVIER and VALENCIENNES, Hist. Nat. Poiss., IV, 1829, p. 500; Kamchatka.

Gasterosteus insculptus RICHARDSON, Last Arctic Voyage, 1854, p. 10, pl. XXV, figs. 1, 2, and 3; Northumberland and Puget sounds.

Gasterosteus serratus AYRES, Proc. Cal. Acad. Sci., 1855, p. 47; San Francisco.—SAUVAGE, Revision des Epinoches, 1874, p. 13.

Gasterosteus intermedius GIRARD, Proc. Acad. Nat. Sci. Phila., 1856, p. 135; Cape Flattery.

Gasterosteus aculeatus cataphractus JORDAN and GILBERT, Synopsis, 1883, p. 396.

Gasterosteus cataphractus JORDAN and EVERMANN, Fishes N. and M. Amer., I, 1898, p. 749.

Gasterosteus aculeatus ISHIKAWA, Prel. Cat., 1897, p. 58; Hokkaido, Kuriles, Ugo, Yechigo, Shimotsuke, Musashi, Usen, Niigata.

Gasterosteus williamsoni GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 103; Williamson's Pass, near Saugus, California; naked form.

Gasterosteus microcephalus GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 133; Kaweah R., Tulare Lake; half-mailed form.

Gasterosteus plebeius GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 147; Presidio; half mailed.

Gasterosteus inopinatus GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 147; Presidio; half mailed.

Gasterosteus pugetti GIRARD, Proc. Acad. Nat. Sci. Phila., 1856, p. 135; Fort Steilacoom, Washington; half mailed.

The following description is taken from a specimen 85 mm. long from Ugo, northwest Japan:

Head $3\frac{1}{2}$; depth $4\frac{1}{2}$; eye $3\frac{4}{5}$. Dorsal II–I, 13; anal I, 10. Body slender, compressed; head small and pointed; mouth oblique, maxillary not reaching eye; caudal peduncle depressed, keeled. Processes from shoulder girdle slightly divergent, leaving a narrow, naked area on breast; naked area in front of pectorals equal to length of snout. Dorsal spines long and slender, the length equaling distance from snout to pupil; third dorsal and anal spines very small, curved; ventral spines long, slender, as long as snout and eye, or even longer in some specimens; serrate at base and with basal cusp; ventral plate as long as spine in many specimens, narrow, the greatest width $3\frac{1}{2}$ in length. Lateral armature complete, the plates gradually reduced in size posteriorly, forming a distinct caudal keel. Dark grayish or bluish black above, silvery below, with a few dark punctulations, thickest on caudal peduncle and near tip of ventral spines. Alaska, Kamchatka, and Japan. Very abundant northward; the mailed form rarely or never entering fresh water.

We have also marine specimens from Kushiro and northern Japan, which we have compared with specimens from Alaska and Puget Sound, and have found them to be similar.

Specimens from Ibi and Mino rivers near Ogaki in Mino seem to be inseparable from the naked specimens from Colton, California (called "*Gasterosteus williamsoni*"). They differ greatly from the marine form in being deeper, in having the ventral plate broad and short, in being only partially armed, in being conspicuously mottled, and in exhibiting all of the differences which fresh-water specimens at the extreme of variation from California and Alaska exhibit. Since it has not been possible to satisfactorily separate the Western American fresh-water species from those found in the sea, we can not consider these as distinct even though we have no intergrading forms at hand.

Formulæ of soft rays of dorsal and anal:

Locality.	Ugo.			Kushiro.		N. Japan.			Puget Sound.					Ibi River.					Mino, Japan.		
Dorsal	14	13	13	12	11	13	14	13	13	12	14	12	14	12	11	13	12	11	11	11	12
Anal	11	10	10	9	8	10	9	9	9	9	10	9	10	10	9	9	9	8	8	9	8

(*κατάφρακτος*, *cataphractus*, mailed.)

2. PYGOSTEUS Brevoort.

Pygosteus (Brevoort) GILL, Cat. Fishes East Coast North America, 1861, p. 39; name only.

Pygosteus GILL, Canadian Naturalist, II, 1865, p. 8 (*occidentalis*).

Gasterostea SAUVAGE, Revision des Epinoches, 1874, p. 29 (*pungitius*).

This genus is characterized by the presence of 9 to 11 divergent spines and by the weakness of its innominate bones. The gill membranes form a broad fold across the isthmus. Vertebræ 14 + 18 = 32. (πυγή, pubic region; ὀστέον, bone.)

a. Dorsal with 8 spines .... *steindachneri*, 2.
aa. Dorsal with 11 or 12 spines .... *undecimalis*, 3.

2. PYGOSTEUS STEINDACHNERI Jordan and Snyder.

Gasterosteus japonicus STEINDACHNER, Ichthy. Beitr., IX, p. 27, pl. III, fig. 2; Gulf of Strielok, near Vladivostok. (Not of Houttuyn.)

Pygosteus steindachneri JORDAN and SNYDER, Proceedings U. S. Nat. Mus., 1901, p. 747, after Steindachner.

Gasterosteus pungitius ISHIKAWA, Prel. Cat., 1897, p. 59; Lake Inokashiro, near Tokyo.

Gasterosteus sp. ISHIKAWA, Prel. Cat., 1897, p. 59; Yamashiro.

The following description is taken from 4 specimens from Yamashiro:

Head $3\frac{3}{5}$ in length; depth $4\frac{1}{4}$. Dorsal VIII–11; anal I–8, or 9. Diameter of eye equal to snout or slightly greater, contained $3\frac{1}{2}$ times in head; width of interorbital two-thirds diameter of eye; maxillary barely reaching to under anterior edge of the eye in the males, slightly shorter in the females.

Length of ventral spines equal to distance from tip of snout to middle of eye; length of middle dorsal spines two-thirds to three-fourths eye, last spine a little longer, equal to anal spine; length of pectoral equals snout and eye; length of anal base equal to dorsal base and equal to length of head without snout.

Anterior part of body with vertical bony plates which decrease in length posteriorly and become small round plates on posterior half of body; on the caudal peduncle they form a sharp keel; they number from 32 to 35.

Color in spirits very light yellowish brown with only a trace of small dusky punctulations. The membrane of the spinous dorsal dusky or conspicuously black. The soft dorsal and anal ranging from colorless to dusky. Pectoral and caudal without color.

Numerous specimens taken from a pond at Inokashiro, Musashi, near Tokyo, and one specimen from Aomori differ only from these in being entirely devoid of plates and in being much darker or more dusky. The fins are all more or less dusky and the membrane of the spinous dorsal is not darker than the body color. Of 16 specimens counted an equal number have 8 and 9 spines. Both these and the

mailed specimens from Yamashiro were presented by the Imperial Museum from the many examples collected by Dr. Ishikawa.

Steindachner's specimens seem to have been more slender and to have had higher spines than ours.

(Named for Dr. Franz Steindachner.)

3. PYGOSTEUS UNDECIMALIS Jordan and Starks, new species.

Head $3\frac{1}{5}$ to $3\frac{2}{5}$ in length; depth 5 to $5\frac{1}{2}$. Dorsal XI or XII (in an equal number of specimens) 10 or 11; anal I, 9. Eye $3\frac{1}{2}$ in head; snout 4; interorbital slightly less than diameter of eye. Maxillary reaching slightly past anterior margin of eye. Depth of head $1\frac{1}{2}$ to $1\frac{3}{4}$ its length.

Ventral spines very short and slender, equaling in length two-thirds to three-fourths diameter of eye. The dorsal spines are subequal in length to the next to the last and are scarcely half the diameter of the eye in length. The last one is about a third higher and is equal in length to the anal spine.

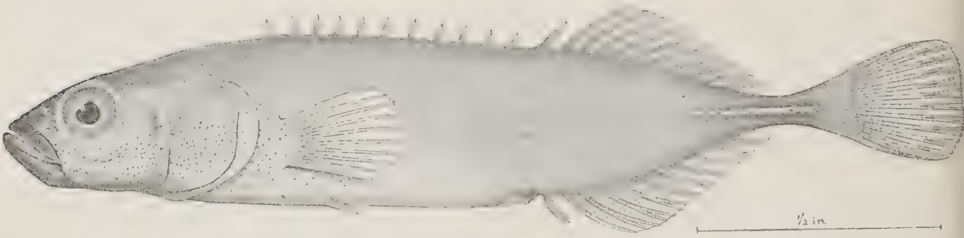

FIG. 1.—PYGOSTEUS UNDECIMALIS.

The body is entirely devoid of bony plates in our specimens, except in one example where a few plates form a keel on the caudal peduncle.

Color dark brown above, lighter below, all of the fins dusky.

This species differs from *Pygosteus steindachneri* in having a more slender form, a slightly longer head, shorter and more slender ventral spines, and particularly in having more numerous and shorter dorsal spines. The mouth appears to be larger and the caudal peduncle to be thicker. The color is darker.

Six specimens, the longest 53 mm. in length, presented by the Sapporo Museum, were taken at Chitose in Hokkaido by Mr. Nozawa. The type is No. 7119, Leland Stanford Junior University Museum.

(*undecim*, eleven.)

Family II. AULORHYNCHIDÆ.

3. AULICHTHYS Brevoort.

Aulichthys (Brevoort) GILL, Proc. Acad. Nat. Sci. Phila., 1862, p. 234, (*japonicus*).

Lateral line with a series of sharply keeled plates, each ending in a spine; pectoral fin not emarginate; ventrals inserted under middle of length of the pectoral fin.

Northern Japan: one species known, well separated from the Californian *Aulorhynchus flavidus*, by the row of lateral spines; the fin rays about the same.

(αὐλός, tube; ἰχθύς, fish.)

4. AULICHTHYS JAPONICUS Brevoort.

Aulichthys japonicus (Brevoort), GILL, Proc. Acad. Nat. Sci. Phila., 1862, p. 234; Shimoda.—JORDAN and SNYDER, Check List Fishes Japan, 1901, p. 60; Yokohama.

Aulorhynchus japonicus STEINDACHNER Ichth. Beitr., X, 1881, p. 1, pl. v, fig. 1; Yokohama.

Fistulariidæ? Genus? Species? ISHIKAWA, Prel. Cat., 1897, p. 31; Nos. 551, 552; Boshu.

The following description is from a specimen from Tokyo, 15 cm. long.

Head 3¾ in length; depth 2 in snout. Dorsal XXV–9; anal 1–10. Lateral plates 55. Postcaudal plates 13. Eye 4 in snout, 2 in postorbital part of head.

The mouth is small, the maxillary is contained 2½ times in the mandible, which is about half the length of the snout. From the backward-extending process from the maxillary a shallow channel runs backward on top of the snout to within a distance of the eye equal to the diameter of the eye. From the supraorbital rim a short channel runs forward to each side of the termination of the anterior median channel. The interorbital space is slightly convex and somewhat rugose. The length of the opercle is twice that of the rest of the postorbital part of the head.

The pectoral fin is inserted a distance equal to the length of the opercle from the edge of the opercle. The lower rays are the longest; their length is equal to their distance from the posterior orbital margin. The front of the dorsal is midway between the base of the caudal and the middle of the opercle. The anal is directly under the soft dorsal and about equal to it in length. Where the anal and the dorsal are depressed the tips of the longest rays just reach to the base of the last ray. The length of the caudal equals the length of the postorbital part of the head. The lower edge of the shoulder girdle is rough and is only covered by thin skin; it appears as a line of dermal bone and runs back nearly to a similar but wider line formed by the edge of pubic bones. The length of the ventrals equals the diameter of the eye.

Caudal slightly dusky, other fins colorless; top of head dark; opercles dusky above with fine brown points; a dark brown streak runs along preorbital region to middle of eye.

We have specimens from Tokyo, Matsushima, and Boshu. The species is not rare in northern Japan on sandy shores.

Family III. AULOSTOMIDÆ.

Body compressed, elongate, covered with small, ctenoid scales. Lateral line continuous. Head long; mouth small, at the end of a long, compressed tube. Lower jaw prominent, with a barbel at the symphysis. Premaxillary feeble, not protractile; maxillary broad, triangular, with a supplemental bone. Teeth minute, in bands on lower jaw and vomer. Branchiostegals 4. Gills 4, a slit behind the fourth. Pseudobranchiæ well developed. Gill rakers obsolete. Gill membranes separate, free from the isthmus. Air bladder large. Post-temporal free from cranium. Spinous dorsal present, of 8-12 very slender free spines; soft dorsal and anal rather long, similar posterior, with 23 to 28 rays each; caudal small, rhombic, the middle rays longest, but not produced into a filament; ventrals abdominal, of 6 rays, all articulated; pectorals broad, rounded, the space in front of them scaly. First four vertebræ elongated. Two pyloric caeca. A single genus, with two species, found in tropical seas.

4. AULOSTOMUS Lacépède.

Aulostomus Lacépède, Hist. Nat. Poiss., V, 1803, p. 357 (*chinensis*).
Aulostoma Schlegel, Fauna Japonica, Poiss., 1845, p. 320; change of spelling.
Polyterichthys Bleeker, Ternate, II, p. 608 (*valentini*=*chinensis*).
Solenostomus Gronow, Cat. Fishes, Ed. Gray, 1854, p. 146 (*chinensis*).

Characters of the genus included above.
(αὐλός, tube; στόμα, mouth.)

5. AULOSTOMUS[a] VALENTINI Bleeker.

Valentijn, Oud- en Nieuw-Oost-Ind., Amboyna, III, 1725, pp. 323, 448, 494.
Polypterichthys valentini Bleeker, Ternate II, about 1850, p. 608; Ternate.
Aulostoma sinensis Schlegel, Fauna Japonica, 1845, p. 520; "Très rare dans les mers du Japon."
Aulostoma chinense Günther, Cat. Fish., III, 1861, p. 538; Amboyna; Aneitum (not *Aulostomus chinensis* Lacépède, which, after Linnaeus, is a West Indian species.

The following description is from a specimen 48 cm. in length from Honolulu. Head 3 in length; depth 11. Dorsal XI-26; anal 26; scales about 230.

Body elongate, compressed, the least depth just behind base of pectorals where the body is constricted below. Body expanding vertically somewhat at soft dorsal and anal, and abrupt narrowing at caudal peduncle, which is long and slender with parallel sides.

Eye contained $2\frac{3}{4}$ in post orbital part of head, $7\frac{1}{2}$ in snout. Lower jaw somewhat hooked up at tip over front of premaxillary. Maxillaries very broad, their width a little greater than eye and twice as long.

[a] *Fistularia chinensis* Linnæus is based chiefly in the *Solenostomus cauda rotundata* of Gronow, which is the West Indian species, *Aulostomus coloratus*. The latter species should properly bear the name *chinensis*.

Scales fine, strongly ctenoid, at nape becoming somewhat embedded. Area in front of pectorals closely scaled. Head naked.

Pectorals short and broad; their length equals twice the diameter of eye. Ventrals inserted midway between base of caudal and middle of eye. Dorsal placed directly over anal, which is of equal length. Base of dorsal equal to postorbital part of head and half eye. Length of caudal contained $3\frac{3}{5}$ in length of snout.

Color in alcohol brownish, with 10 or 11 narrow light crossbars, between each of which is a more or less conspicuous broken bar composed of diffused spots. Fins yellowish. A black stripe across base of dorsal and anal rays; a round black spot on upper and lower rays of caudal; a black spot on base of ventrals; and one on middle of maxillary. Other specimens very dark, with scarcely any crossbars. Others show conspicuous longitudinal light bars.

This species, common in the tropical seas from Hawaii to India, is recorded by Schlegel as very rare in Japan. It doubtless belongs to the fauna of the Riukiu Islands.

(Named for its discoverer, Fr. Valentijn, who wrote in 1725 on the "Oud- en Nieuw-Oost-Indien" and the "Waterdieren van Amboina.")

Family IV. FISTULARIIDÆ.

Body extremely elongate, much depressed, broader than deep. Scaleless, but having bony plates present on various parts of the body, mostly covered by the skin. Head very long, the anterior bones of the skull much produced, forming a long tube, which terminates in the narrow mouth; this tube formed by the symplectic, proethmoid, metapterygoid, mesopterygoid, quadrate, palatines, vomer, and mesethmoid. Both jaws, and usually the vomer and palatines also, with minute teeth; membrane uniting the bones of the tubes below, very lax, so that the tube is capable of much dilation. Post-temporal coössified with the cranium. Branchiostegals 5 to 7; gills 4, a slit behind the fourth. Gill membranes separate, free from the isthmus; gill rakers obsolete. Basibranchial elements wanting. Fourth superior pharyngeal missing or anchylosed to third. Pseudobranchiæ present. Air bladder large. Spinous dorsal fin entirely absent; soft dorsal short, posterior, somewhat elevated; anal fin opposite it and similar; caudal fin forked, the middle rays produced into a long filament; pectorals small, with a broad base, preceded by a smooth area; processes from hypocoracaid greatly lengthened; supraclavicles very small; ventral fins very small, wide apart, abdominal, far in advance of the dorsal, composed of 6 soft rays. Pyloric cœca few; intestine short. Vertebræ very numerous (4+44 to 49+28 to 33); the first four vertebræ very long. Fishes of the tropical seas, related to the sticklebacks in structure, but with prolonged snout and different ventral fins. A single genus, with a few species.

5. FISTULARIA Linnæus.

Solenostomus KLEIN, Missus, IV, 1740, p. 23 (nonbinomial).
Fistularia LINNÆUS, Syst. Nat., 10th ed., 1758, p. 312 (*tabacaria*).
Cannorhynchus CANTOR, Malayan Fishes, 1850, p. 211 (*tabacaria; Fistularia* being regarded as preoccupied by Donati in 1750 for a pre-Linnæan genus of Polyps).
Flagellaria GRONOW, Cat. Fishes, 1854, p. 146 (*fistularis=tabacaria*).

Characters of the genus included above. The bony shields, characteristic of this genus, are the following:

1. The narrow strip along the median line of the back behind the skull (confluent neural spines).

2. The pair of broader lateral dorsal shields. These shields are the longest, provided anteriorly with a ridge, which is prolonged and extends far backward between the muscles of the back. This ridge is flexible, and does not interfere with the lateral movements of the fish. It appears to serve as a base for the attachment of muscular fibers.

3. The narrow shield on the side is the postclavicle, its posterior part being dilated and fixed to the lateral dorsal shields.

4. The ventral shields are the processes from the hypocoracoids. Their posterior half is broadest, much pitted inferiorly. They are narrower before the middle, leaving a free lanceolate space between them, and are again a little widened anteriorly, where they join the clavicle and urohyal. These plates extend as far backward as the anchylosed vertebræ.

(*fistula*, a tube or pipe.)

a. Upper lateral edges on snout sharply serrated.
b. Two middle ridges on snout well separated, diverging on anterior part of snout, converging finally on its foremost part; skin nearly smooth. Color greenish .... *depressa*, 6.
bb. Two middle ridges on snout close together and parallel on anterior half of its length, slowly converging forward from the middle; skin rough. Color, reddish .... *petimba*, 7.

6. FISTULARIA DEPRESSA Günther

YAGARA (ARROW-SHAFT).

Fistularia depressa GÜNTHER, Shore Fishes Challenger, 1880, p. 69, pl. XXXII, fig. D; Sulu Islands, Natal, Zanzibar, Amboyna, China, New Guinea, New South Wales, Fiji, Lower California.—JORDAN and EVERMANN, Fishes N. and M. Amer., 1, 1898, p. 757; Gulf of California, Panama.

The following description was taken from a small specimen 31 cm. in length (without caudal filament), from Wakanoura.

Head $2\frac{2}{3}$ in length. Depth at pectoral fins equal to long diameter of eye. Width just behind pectorals three-fifths of width at a point just behind ventrals. Dorsal 15; anal 14.

Body elongate, depressed, as viewed from above the sides are nearly parallel for a short distance behind pectorals, where it is narrower

than posterior part of head, but grows abruptly broader at the posterior end of the upper lateral plates and tapers gradually to the caudal.

The jaws are armed with a row of fine teeth. The maxillary is contained $8\frac{1}{4}$ times in the snout, the mandible $5\frac{1}{5}$ times. Eye nearly twice as long as high; extreme length of orbit equal to length of maxillary. Interorbital space somewhat concave, less so than in *F. petimba*, in larger specimens it is flat at the sides with a channel along its middle; the width is one-third of orbit. The median ridges on snout diverge anteriorly; the distance between them is everywhere greater or as great as the distance from them to the upper lateral ridge.

The ventrals are inserted from the pectorals a distance equal to the distance of the pectoral from the anterior margin of the eye. They are separated at their base by a space equal to the long diameter of the eye. The dorsal and anal are directly opposite to each other and similar in shape. The skin is everywhere smooth to the touch.

All of our specimens from Japan are plain brown greenish above, but as specimens from other localities may be either plain brown or with longitudinal stripes and spots of blue, probably blue-spotted examples occur.

The following color description was taken from a fresh specimen from Panama, 69 cm. in length:

Olive brown on upper parts, white below. A pair of narrow blue stripes, interrupted anteriorly and posteriorly, begin at the nape, diverge backward, and cross the lateral line just in front of the point where it becomes straight, then runs just above and parallel to the lateral line as far as the tail. Another pair of streaks, made each of blue spots, run close along each side of mid-dorsal line, from a point above axil of pectorals to front of dorsal. Behind dorsal, a single series of spots occupies the median line of back.

We have compared specimens from Panama, La Paz, Mexico, and from the Hawaiian Islands with our Japanese material and can appreciate no difference. The species occurs also in Samoa.

Several specimens under 32 cm. in length were collected at Wakanoura, Misaki, and Matsushima.

(*depressus*, depressed.)

7. FISTULARIA PETIMBA Lacépède.

YAGARA.

Fistularia PIPE, John White, Voyage New South Wales, pl. LXIV, fig. 2.

Fistularia tabacaria var. BLOCH, Ichth., 1794, pl. CCCLXXXVII, fig. 2, "Coll. Linke at Leipzig;" wrongly figured as spotted with blue; snout serrate; 2 caudal filaments.

Fistularia petimba LACÉPÈDE, Hist. Nat. Poiss., V, 1803, p. 349 (excl. syn.); New Britain, Isle of Reunion, equatorial Pacific; based on specimens and manuscripts of Commerson; snout serrate; body immaculate.—JORDAN and EVERMANN, Fish N. and M. Amer., I, 1898, p. 758.

Fistularia serrata Cuvier, Règne Animal, 1st ed., 1817, p. 349 (after Bloch).—Günther, Cat., III, 1861, p. 533.—Günther, Shore Fishes, Challenger, p. 68, pl. xxxii, fig. C, 1880.—Jordan and Gilbert, Synopsis, 1883, p. 390.—Ishikawa, Prel. Cat., 1897, p. 31; Tokyo, Kii.

Fistularia immaculata Cuvier, Règne Animal, 1st ed., 1817, p. 349; Sea of the Indies; after Commerson and John White.

Fistularia commersonii Rüppell, Neue Wirbelthiere, 1834, p. 142; Red Sea.

The following description was taken from a specimen 30 cm. in length from Wakanoura:

Head $2\frac{1}{2}$ in length; depth at pectorals a little less than long diameter of eye. Dorsal 15; anal 14.

This species differs from *F. depressa* in the following characters:

The ridges on the top of snout are close together and parallel. The distance between them is always much less than the distance from them to the upper lateral ridge of snout. The head is more deeply sculptured and the ridges are rougher. The interorbital space is deeply concave and without flat supraorbital areas in the adult. The species may be at once distinguished by the touch, the skin feeling harsh like very fine shagreen. The lateral line is armed posteriorly with sharp bony plates.

Some of our specimens show faint traces of broad cross-bars about as wide as the diameter of the eye; 3 or 4 are on the snout and 12 or 14 on the rest of the body. It is pale or dull reddish brown in life. It seems to be rather less common than *F. depressa*, but neither species is rare in shallow bays of Japan. This species was found at Wakanoura, Misaki, and Nagasaki.

(*petimbuaba*, a Portuguese name.)

Family V. MACRORHAMPHOSIDÆ.

SNIPE-FISHES.

Body compressed, oblong, or elevated, covered with small, rough scales; no lateral line; some bony strips on the side of the back and on the margin of the thorax and abdomen, the former sometimes confluent into a shield. Bones of the skull much prolonged anteriorly, forming a long tube which bears the short jaws at the end; no teeth. Gill openings wide; branchiostegals 4. Branchihyals and pharyngeals mostly present, the fourth superior epibranchial and the first and fourth superior pharyngeals only wanting. Two dorsal fins, the first of 4 to 7 spines, the second of which is very long and strong; soft dorsal and anal moderate; ventral fins small, abdominal, of 1 spine and 4 or 5 soft rays; pectorals short; caudal fin emarginate, its middle rays not produced. Air bladder large; pseudobranchiæ present. Gills 4, a slit behind the fourth; vertebræ about 24, the four anterior ones much lengthened; no pyloric cœca; intestinal canal short. Three or more species, chiefly of the Old World, placed in two genera, *Macrorhamphosus* and *Centriscops*.

6. MACRORHAMPHOSUS Lacépède.

Macrorhamphosus LACÉPÈDE, Hist. Nat. Poiss, V, 1803, p. 136 (*cornutus=scolopax*).
Centriscus CUVIER, Règne Anim., 1st. ed., II, 1817, p. 350 (*scolopax*, not *Centriscus*, Linnæus, which was based on *scutatus* alone).
Macrognathus GRONOW, Cat. Fishes, 1854, p. 147 (*scolopax*).
Orthichthys GILL, Proc. Ac. Nat. Sci. Phila., 1862, p. 234 (*velitaris*).

Body oblong, graduating into the caudal peduncle; back straight; dorsal spines about 7. Characters otherwise included above.

(μακρός, long; ῥάμφος, snout.)

a. Body deep, the depth 4 in length to base of caudal..................... *sagifue*, 8.
aa. Body more slender, the depth $4\frac{1}{2}$ in length to base of caudal......... *japonicus*, 9.

8. MACRORHAMPHOSUS SAGIFUE Jordan and Starks, new species.

SAGIFUE (BIRD FLUTE).

Centriscus sp. ISHIKAWA, Prel. Cat., 1897, p. 32; Kagoshima.

Head, 2 to $2\frac{1}{8}$ in length; depth, 4 to $4\frac{1}{4}$; eye $5\frac{1}{2}$ to 6 in head, $3\frac{1}{2}$ to 4 in snout; snout 3 to $3\frac{1}{6}$ in length.

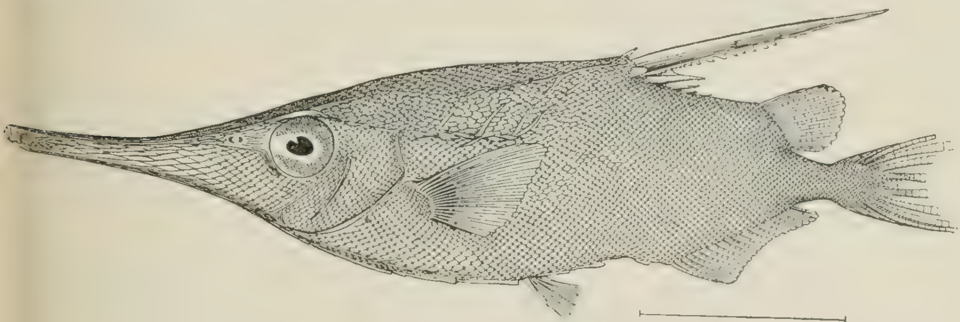

FIG. 2.—MACRORHAMPHOSUS SAGIFUE.

Dorsal V–12; anal 18 (or 19, counting the last very small slender ray, which is crowded close to the preceding one.)

Outline of head concave from tip of snout to occiput and from mandible to tip of clavicles. Dorsal outline of body convex from occiput to dorsal spine, nearly level between dorsals dropping steeply oblique at anal base to caudal peduncle, less steep on caudal peduncle. Ventral outline evenly curved from shoulder girdle to caudal peduncle.

Mouth small, toothless; maxillary scarcely as long as the diameter of pupil. A slight ridge runs from above eye along upper lateral edge of snout, conspicuous near eye, growing lower anteriorly. Another ridge runs from the anterior margin of the eye straight forward and unites with the upper ridge. The preopercular ridge touches the posterior margin of the orbit and runs obliquely in a straight line nearly to lower margin of head under anterior margin of eye and is thence continued forward following the contour of snout.

Bony strips along back and armature of abdomen as described for *M. scolopax*.

The length of the second dorsal spine is variable, reaching only to the base of the rudimentary caudal rays in some examples, to above the middle of the longest caudal rays in the others; its insertion is midway between the base of the middle caudal rays and a point midway between the eye and the edge of the opercle. The pectorals equal in length the base of the anal, or the eye and postorbital part of the head.

Color in spirits silvery below, brownish above; fins colorless; pale red in life.

We have compared this species with two specimens of *Macrorhamphosus scolopax* from the Canary Islands. From them it differs in being a little more slender, and in having a slightly smaller eye and longer snout.

Specimens from Misaki and Enoura on Sagami Bay and from deeper water at Sagami and Saruga Bays, where it was dredged by the U. S. Fish Commission steamer *Albatross*. The type from Enoura is numbered 7125 in Leland Stanford, Junior, University Museum. A co-type is in the U. S. National Museum. The species is common in rather deep waters along the coast of Japan.

(*sagifue*, the Japanese name.)

9. MACRORHAMPHOSUS JAPONICUS Günther.

Centriscus japonicus GÜNTHER, Cat. Fish., III, 1861, p. 522; Japan; China.

Dorsal IV or V–11; anal 18 or 19.

The height of the body is contained $2\frac{3}{5}$ to 3 times in distance of operculum from base of caudal. Second dorsal spine very strong, not (or very indistinctly) denticulated posteriorly, the length about one-fourth or two-ninths of the distance of the opercle from the caudal.

The above is Dr. Günther's description of *Macrorhamphosus gracilis* of Europe From this species he differentiates *M. japonicus* in having a shorter dorsal spine.

The species was not seen by Jordan and Snyder. The type of Dr. Günther was doubtless from Misaki.

Family VI. CENTRISCIDÆ.

Form of body elongate, much compressed. Anterior bones of skull much produced and forming a long tube terminating in a small mouth. Body covered with a bony dorsal cuirass which is connate with the internal skeleton. Posteriorly it terminates in a long spine with or without a movable spine at its end. The longitudinal axis of the tail is deflected from that of the trunk by the encroachment of the dorsal cuirass over it. Vertical fins including a spinous dorsal crowded together under the terminal spine of dorsal cuirass. Ventrals

abdominal. Teeth none. Parietals absent. Posttemporal suturally connected to cranium; supraclavicle present. Ribs developed. Post-clavicles present. East Indies. Species few and small, fantastically formed, the translucent carapace suggesting that of a shrimp.

7. ÆOLISCUS Jordan and Starks, new genus (strigatus).

This genus differs from *Centriscus* Linnaeus (*Amphisile* Cuvier),[a] chiefly in having the first dorsal spine borne by the spine which terminates the cuirass. The dorsal cuirass of *Centriscus* ends posteriorly in a long unjointed spine. This genus *Æoliscus* includes also *Æoliscus punctulatus* (Bianconi) and perhaps also the fossil species called *Amphisile heinrichi.*

(*αἰόλος*, moving.)

10. ÆOLISCUS STRIGATUS (Günther).

Amphisile strigata Günther, Cat. Fish., III, 1861, p. 28; Java.

Head $2\frac{1}{2}$ in length to base of soft dorsal rays; depth 3 in head; orbit 11 or 12 in head; $1\frac{2}{3}$ to 2 in postorbital part of head; interorbital $\frac{4}{5}$ orbit. Dorsal III, 10; anal 12.

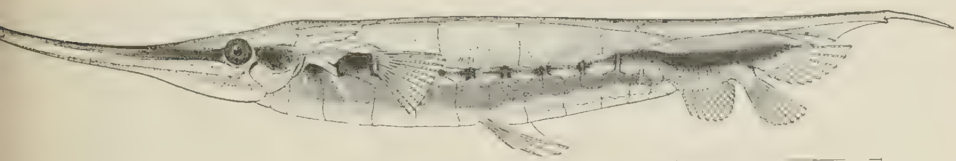

Fig. 3.—Æoliscus strigatus.

Body very much compressed and rather elongate, resembling in transverse section a razor blade—thin and rounded above, tapering below to an extremely thin drawn out cutting edge. Head and body cuirassed with smooth, bony plates; tapering anteriorly into a long bony snout; terminating posteriorly in a long spine.

Outline of head concave above from occiput to tip of snout; the rostral tube bent upward anteriorly and terminating in an extremely small toothless mouth. The length of the mandible is less than half the diameter of the eye. The interorbital is convex and longitudinally striated; its width is equal to the diameter of the eye. The supraorbital margin of the eye is a projecting rim.

The third lateral plate of the body is nearly twice as long as deep; its lower edge is midway between the outline of the back above it and the base of the ventral fin. There are 11 lower ventral plates (ribs), 2 in front of the pectoral and 9 behind.

[a] The name *Centriscus* Linnaeus, was based on *Centriscus scutatus* alone, described after Gronow. It is therefore equivalent to *Amphisile* of Cuvier and *Acentrachme* of Gill, and can be used neither for *Macrorhamphosus* nor for *Æoliscus*.

Directly below the posterior spines the vertical fins are crowded. The spinous dorsal and soft dorsal point nearly straight backward, the caudal obliquely downward, and the anal straight downward. The pectoral is inserted behind the opercle a distance equal to the diameter of the eye and the postorbital part of the head; its posterior margin is slightly concave; the extreme upper and lower rays are the longest, the former a little longer than the latter. The ventrals are inserted midway between a point below the anterior orbital rim and the base of the posterior anal ray. They are in some individuals long (probably a sexual variation) and are contained $1\frac{1}{5}$ in the depth of the body above them; in others they are short, equal to or slightly exceeding the diameter of the eye. The first dorsal spine is equal in length to or slightly exceeds the distance of the pectoral from the edge of the opercle. From the end of the process which bears it a tiny spine projects downward and is connected to the dorsal spine by a membrane. The fish is evidently able to lock the dorsal spine in a horizontal position. When declined it projects downward at right angles to the spine that bears it. The second and third dorsal spines are curved slightly downward. The second reaches about three-fifths of the distance from its base to the base of the first. The tips of the dorsal rays reach a very little past the tip of the second dorsal. The length of the caudal rays are equal to the length of the dorsal rays. The anal rays are shorter and are about equal to the length of the base of the fin.

Color brown, lighter above; a dark streak running through the eye appears as a double streak on opercles, thence takes an irregular course to pectoral base, behind which it is continued along the naked portion of the body below lateral plates, where it widens slightly at each rib; behind it crosses the caudal vertebræ and ends between the spinous and soft dorsals.

Numerous specimens were obtained from Yaeyama, Ishigaki Island, Riukiu, having been collected by Capt. Alan Owston.

(*strigatus*, striped.)

SUMMARY.

Suborder HEMIBRANCHII.

Family I. Gasterosteidæ.

1. *Gasterosteus* (Artedi) Linnæus.

1. *cataphractus* (Pallas); Kushiro, Ibi River, Mino River.

2. *Pygosteus* Brevoort.

2. *steindachneri* Jordan and Snyder; Yamashiro, Inokashiro, Aomori.
3. *undecimalis* Jordan and Starks; Chitose, Hokkaido.

Family II. AULORHYNCHIDÆ.

3. *Aulichthys* Brevoort.

4. *japonicus* Brevoort; Tokyo, Matsushima, Boshu.

Family III. AULOSTOMIDÆ.

4. *Aulostomus* Lacépède.

5. *valentini* Bleeker.

Family IV. FISTULARIIDÆ.

5. *Fistularia* Linnæus.

6. *depressa* Günther; Wakanoura, Misaki, Matsushima Bay.
7. *petimba* Lacépède; Wakanoura, Misaki, Nagasaki.

Family V. MACRORHAMPHOSIDÆ.

6. *Macrorhamphosus* Lacépède.

8. *sagifue* Jordan and Starks; Misaki, Enoura, Sagami Bay, Saruga Bay.
9. *japonicus* Günther.

Family VI. CENTRISCIDÆ.

7. *Æoliscus* Jordan and Starks.

10. *strigatus* (Günther); Ishigaki Islands.

DESCRIPTIONS OF NEW SPECIES OF HAWAIIAN CRABS.

By Mary J. Rathbun,

Second Assistant Curator, Division of Marine Invertebrates.

Mr. H. W. Henshaw, of Hilo, Hawaii, has from time to time sent crustaceans to the U. S. National Museum. Among them are two crabs which appear to be undescribed. The species of *Cyclograpsus* has since been taken also by Mr. R. C. McGregor.

The figures are drawn by Miss Sigrid Bentzon.

CYCLOGRAPSUS HENSHAWI, new species.

Carapace four-fifths as long as broad, sides subparallel for nearly three-fourths of their length. Surface almost smooth, punctate, the punctæ coarse on the front, a few depressed granules in the antero-lateral region; cervical suture and gastro-cardiac suture faintly marked. Postero-lateral region crossed obliquely by broken granulated lines. Margin of front not visible in a dorsal view, straight, about three-eighths as wide as carapace, granulate. Lateral edges margined, granulate, and entire. Alcoholic specimens show six white spots on the anterior half of the carapace, one on either side of the gastric region just in front of the middle and two farther forward, arranged transversely nearer the lateral margin.

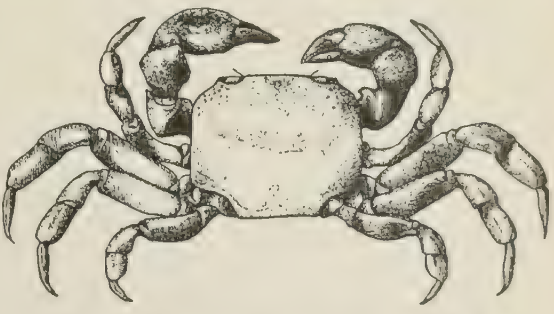

Fig. 1.—Cyclograpsus henshawi, male, × 1⅓.

Chelipeds subequal. Merus granulate on upper margin and sparingly so on outer surface; inner margin denticulate, usually furnished with a lobe on the distal half. Carpus for the most part smooth; inner margin and angle granulate. Hand and fingers smooth; fingers gaping, inner edges crenulate.

The ambulatory legs are a little rough. The merus joints are granulate on the anterior margin, the granules continued sparingly on the

upper surface. The anterior margin of the propodi is covered with short black bristles. The dactyli have six rows of the same, in which the spinules are almost hidden.

Dimensions.—Length of male 13.5 mm.; width 17 mm.; fronto-orbital width 11.7 mm.; width of front 6.2 mm. Length of largest male 16 mm.; width 19.5 mm.

Localities.—Hilo, Hawaii; H. W. Henshaw, collector (types, Cat. No. 22857). Kahului, Maui; R. C. McGregor, collector. Oahu, *Galathea* expedition; received from Copenhagen Museum, labeled "*C. cinereus* Dana."

This little crab is not rare in the Hawaiian Islands. It has been found by Mr. Henshaw under stones at high-water mark, associated with *C. granulatus* Dana, which may be distinguished by its arcuate side margins and the dense granulation of the anterior two-fifths of the carapace. *C. cinereus* Dana, of which there are specimens in the U. S. National Museum from San Lorenzo Island, Peru, has a narrower carapace, and the abdomen of the male wider and of a different form (see Dana's figure). The new species approaches nearest to *C. parvulus* de Man[a] from Atjeh, but the front is wider in our species, the upper margin of the orbit is not directed backward, the merus of the maxilliped is longer, and the sixth segment of the abdomen of the male shorter.

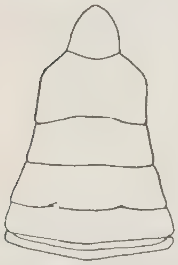

FIG. 2.—CYCLOGRAPSUS HENSHAWI, ABDOMEN OF MALE, $\times 3\frac{1}{3}$.

OZIUS HAWAIIENSIS, new species.

Length of carapace four-sevenths of width. Carapace convex both in a longitudinal and transverse direction. A narrow depressed area extends around the front and antero-lateral region as far as the penultimate tooth. Surface irregularly punctate; the anterior third is roughened with depressed granules and irregular pits. The anterior part of the mesogastric region is very narrow and marked by deep grooves. There is a shallow gastro-cardiac suture; otherwise the boundaries of the regions are not indicated. On either side are two shallow pits disposed obliquely in front of the middle. The fronto-orbital width is three-sevenths of the entire width. The front is about as wide as the orbits, and so deflexed that its real margin is not visible in a dorsal view; the margin is four-lobed, the inner lobes larger than the outer and separated from each other by a deeper and narrower sinus than from the outer. The inner orbital tooth is well marked. Antero-lateral margin cut into four teeth; the first is almost obliterated in the adult, being merged with the orbital angle; its outer margin is longer than that of the second. The second and third are of equal length, the second most prominent.

[a] Zool. Jahrb., Syst., IX, 1896, p. 350; 1898, pl. XXXII, fig. 42.

The subhepatic and subbranchial regions are roughened near the anterior and lateral margins of the carapace. A ridge runs from near the posterior end of the first antero-lateral tooth to the lower margin of the orbit.

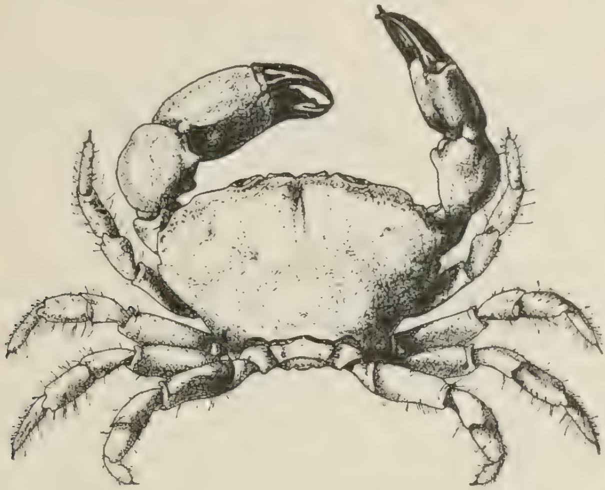

FIG. 3.—OZIUS HAWAIIENSIS, FEMALE, × 1⅕.

Chelipeds unequal (in the female). The merus has a subterminal notch on the upper margin. The outer surface of the carpus and upper surface of the manus are roughened with irregular and mostly transverse pits, the intervening ridges deeply punctate. The carpus has two blunt inner teeth, one below the other. The fingers are black, marked with a few slightly impressed lines of pits; the pollex is wider than the dactylus, which is considerably longer than the upper margin of the palm. The fingers of the larger hand gape a little; each has a larger tooth near the base. The ambulatory legs are sparsely hairy.

FIG. 4.—OZIUS HAWAIIENSIS, MARGIN OF FRONT, × 6⅔.

Dimensions.—Length of female with ova 16 mm.; width 28 mm.; fronto-orbital width 12.5 mm.; width of front 6 mm.

Type locality.—Hilo, Hawaii, under stones at high-water mark; H. W. Henshaw, collector (Cat. No. 22852). Only females and young have been secured.

Ozius hawaiiensis differs from allied species, such as *O. verreauxii* Saussure and *O. truncatus* Milne Edwards, in lacking a sharp ridge on the carapace, extending obliquely inward and forward from the last or penultimate antero-lateral tooth.

CONTRIBUTION TO A MONOGRAPH OF THE INSECTS OF THE ORDER THYSANOPTERA INHABITING NORTH AMERICA.

By Warren Elmer Hinds,
Of the Massachusetts Agricultural College.

INTRODUCTION.

Very little attention has been given to the Thysanoptera of North America. So far as I can learn, descriptions or names of only twenty-three species have thus far (June, 1902) been published, besides three which have been recognized as previously described from Europe. Of the twenty-six species thus known in this country, four at least are certainly unrecognizable (*Limothrips tritici* Packard, *Phlæothrips mali* Fitch, *P. caryæ* Fitch, *Thrips phylloxeræ* Riley). Of the remaining twenty-two, six have been found identical with previously described species and therefore become synonyms—the large number is not surprising as many of the early descriptions are entirely too brief to insure positive identification. Therefore only sixteen species have hitherto been known to occur in this country. We may say that almost no systematic work has been done on the order in the United States, and, with the exception of a study of the "Thripidæ of Iowa," by Miss Alice M. Beach, most of the descriptions are scattered through different publications. I have endeavored to collect and present here such important facts as have already been published relating to members of this order, together with the observations which I have been able to make. An attempt has been made to place the work upon a systematic basis, and in order to make the descriptions uniform, and thus comparative, all the existing types that it has been possible for me to see have been examined and redescribed. In all, thirty-seven species are thus treated in the systematic part of this paper. Other descriptions which it has not been possible for me to place are given together by themselves in the hope that some one more fortunate or skillful than myself may have material by which to identify them.

There are given herein descriptions of eighteen species which I believe to be new, all but two of them having been collected at Amherst, Massachusetts, and within a radius of 2 miles of the Massachusetts Agricultural College, but even this field has not yet been thoroughly collected. The abundance of new species obtained within such narrow limits shows us how very little has been done upon this order and therefore it will not be surprising, when more attention shall be given to these tiny insects by collectors, if this small order, which has been considered as insignificant in numbers as well as in the size of its individuals, should prove to be quite extensive in the number of its species. Of the new species described in this paper, a complete set of types has been deposited in the Massachusetts Agricultural College; a set of cotypes, so far as they exist, has been deposited in the United States National Museum; a third set of cotypes I have retained for my own use, and the remainder I have also deposited in the Massachusetts Agricultural College. The number of specimens from which the species has been described follows each description. Eleven of the thirteen previously described American species have been redescribed as have also a number which I believe have been previously described in Europe. Descriptions of early stages have been given where known and the authority therefor noted in each instance. It will be noticed that in all cases the description of the female precedes that of the male, or the latter may be wanting entirely. Among the Thysanoptera the females are much more abundant than the males and also more characteristic when both are known. For these reasons all of the descriptions are based mainly upon the female. It would be impossible to give a bibliography of the species of this country without including many references to European works. Therefore the bibliography is intended to include the literature of this order for the world rather than for North America alone. Each reference has been numbered so that it could be referred to by number when desired without repeating the whole title. Such references have been made by inserting the bibliographical number inclosed by a parenthesis where authority for a statement is referred to, thus, (1).

I desire here to acknowledge that I am under many obligations to those who have assisted in making this paper more complete by kindly loaning type specimens, without the examination of which the identification of several species could not have been certain. I should state that these types were not loaned to me directly, but to Prof. C. H. Fernald, who kindly took upon himself the responsibility for them, but as I have been the one to profit by them it gives me pleasure to express my thanks to Prof. J. H. Comstock, through whose kindness I was able to see the type of *Limothrips poaphagus;* to Prof. Herbert Osborn for the privilege of examining at my leisure his type of *Thrips*

striata; to Prof. C. P. Gillette for the loan of his supposed *Thrips striatus;* to Prof. H. E. Somers for sending the types of Miss Beach and Professor Osborn, with their kind permission, to Dr. Henry Uzel for the positive identification of *Thrips tabaci* with his *Thrips communis*, and finally to Dr. L. O. Howard and Mr. Theodore Pergande for giving me access to the material in the United States National Museum collection.

This paper forms the major portion of a thesis for the degree of doctor of philosophy at the Massachusetts Agricultural College, where it has been prepared under the supervision of Prof. Charles H. Fernald and Dr. Henry T. Fernald, who have charge of the work in the department of entomology. To both, for the many ways in which they have guided and encouraged me in the work of the past three years, I give my heartiest thanks.

HISTORY OF THYSANOPTERA.

These insects were first described by DeGeer in 1744, under the name Physapus (2). Linnæus ignored this name and placed the four species known to him in a genus which he called *Thrips*, locating it in the order Hemiptera, immediately after his genus *Coccus* (5). In 1806, C. Dumeril raised the group to the rank of a family, which he called Vesitarses or Physapodes but retained it in the order Hemiptera (44). C. F. Fallen (47), in 1814, changed the name of the family to "Thripsites," but did not change its ordinal position, and this name was retained by Newman (61) as the name of a "natural order," which, however, had only family value. In 1825, Latreille (50) used for them the names Thripsides and Physapi. A. H. Haliday, in 1836, published an extensive study of the British insects belonging to this group and concluded that they should be given the rank of an order, for which he proposed the name Thysanoptera (63). Probably about two years later, Burmeister (69) also gave them ordinal rank, with the name Physapoda, since which time most writers have adopted one or the other of these ordinal names. Those who adopt Physapoda appear to base their preference largely upon the priority of Dumeril's use of the name Physapodes, Physopoda (Physapoda) being a re-formation of the term. It does not, however, seem to the writer that this position can be sustained, as at that time there was no genus *Physopus*, DeGeer's name having no standing, as it was given before the tenth edition of Systema Naturæ.[a]

It seems therefore that Haliday was the first to give the group the rank of an order and to apply thereto a properly formed ordinal name: Thysanoptera, from θύσανος, a tassel, and πτερόν, a wing. This basing of the name upon characters of the wings is in accord with general usage in the various orders of insects. I believe that Thysan-

[a] See Canons V and XIII, A. O. U. Code, 1892.

optera can claim priority and correctness of formation and should therefore be adopted.

While the scientific name of the group has been subjected to so many changes, the most frequently used common name has persisted unchanged since the time of Linnæus. It is nothing more or less than the name which he gave to the genus Thrips, and is now applied in the same form to any individual of the order. It is therefore incorrect to drop the "s" when referring to an individual, as is frequently done. Thrips is a Latin name derived from the Greek *θρίψ*, meaning a wood-louse, and is in the singular number and masculine gender, as will be also all generic names of which it forms the termination.

Various other common names based upon two of the most striking characters of the group have also been used to a limited extent: Bladder feet (Blasenfusse or Vesitarses), referring to the peculiar structure of the extremity of the leg, is appropriate and much used by German writers. Fringe-wings, from Thysanoptera, has also been used, but much more rarely.

SYSTEMATIC POSITION OF THYSANOPTERA.

The systematic position of this group has undergone unusual change since its establishment by Linnæus. Working as he did upon the most striking superficial characters, Linnæus recognized in Thrips certain affinities with the Hemiptera-Homoptera, in which order he placed them. About 1828 through the anatomical studies of Straus-Durcheim and Latreille, sufficient evidence was obtained to lead Latreille to separate them from the Hemiptera and place them among the Orthoptera. By other writers they have been regarded as Pseudoneuroptera, but at the present time the general opinion is that they form an order by themselves.

So far as the writer can learn, the best work dealing with this question has been done by Jordan (309). His studies were made principally upon *Heliothrips dracænæ* Heeger, representing the Terebrantia and *Phlœothrips brunnea* Jordan, representing the Tubulifera, but many other species were also considered and his conclusions are based upon anatomical (both external and internal) and biological considerations. The following is a free translation of a portion of Jordan's conclusion.

In regard to the place of Physapoda, we must classify them according to their immersed germ band and their larval form in the line of the Orthoptera, Homoptera, Hemiptera, wherein they should be placed according to their anatomy and biology.

In habits the Physapoda, especially the larvæ, resemble small Cicadellinæ. The hypognathism of Thrips is found in such marked degree that the mouth cone comes to lie under the prothorax as in the case of Homoptera, especially Phytophthira. The number and position of the ocelli resembles the Orthoptera s. l. more than the Homoptera, while the position of the antennæ is similar to that of the Orthoptera

and Aphidæ. In the structure of the mouthparts, the Physapoda are not as far removed from the Orthoptera as are the Rhynchota; the Physapod proboscis is of a type between the biting mouthparts of Orthoptera and the sucking mouth of the Rhynchota, by which it is not meant that the Homoptera have developed from our Physapoda. The biting mouth organs of the Orthoptera are here concealed by the transformation of the mandibles into piercing bristles and the growing together of the labrum with the maxillæ and labium, while the piercing bristles form a short tube to the sucking proboscis. In this respect the Physapoda should be considered as Rhynchota together with the Homoptera and Heteroptera.

Thrips have the free prothorax in common with the Orthoptera s. l. and the Rynchota. The development of the meso and metathorax shows that at least the metasternum and meso-sternum are nearly equal to those in the Orthoptera, while the absence of the metaphragma, which is always present in the Orthoptera, and the disappearance of the long metathoracic muscles which are not reduced there, bring Thrips into close connection with the Homoptera. The first ventral ring is maintained through the absence of the first ventral plate and the entrance of the dorsal plate into the thoracic covering in the Physapoda just as in many Orthoptera s. l., but a quite similar condition is also shown in the first abdominal segment of the Homopterous Psyllidæ, a sign that Orthopteroid characters may be retained even in genuine Rhynchota.

A reduction of the system of venation of the wing takes place in the Phytophthira as in the Physapoda, but not in the same degree in the Orthoptera s. l. The Physapod wing is a Phytophthiran wing in which the large spread is greatly reduced, as in the Pterophoridæ, by the development of long fringes.

In regard to the concentrated nervous system, Thrips come very close to Rhynchota and are far removed from the Orthoptera, but in this connection it is worth noting that the aberrant Mallophaga, provided with biting mouth parts, also possess a concentrated nervous system. Aside from these doubtful cases, all other Orthoptera have a developed chain of ventral ganglia. The tracheal system of Thrips has the small number of three or four pairs of stigmata. We find the stigmata reduced usually in the breathing organs of holometabolous insects. Among the Rhynchota we find it as in the Coccidæ; all other Rhynchota and the Orthoptera are holopneustic. The alimentary canal of Physapoda is characterized by the possession of four malpighian vessels which occur in like manner in all Rhynchota with the exception of the Aphidæ which have none, and the Coccidæ which have two urinary organs. The Orthoptera have a large number of urinary tubes, with the exception of the Termitidæ and Psocidæ with six and the Mallophaga with four. The long, slender œsophagus of Terebrantia which reaches even into the abdomen is found also in the Psyllidæ, the large loop of the midgut of Terebrantia is characteristic of many Homoptera, but in these the enlargement of the loop of the gut running back, takes place at the beginning of the midgut.

The male sexual apparatus, with its simple, often pear-shaped testes, resembles the Mallophaga about as much as the Phytophthira; the female organs, from the rosette arrangement of the ovarian tubes, resembles the tubes in the Rhynchota; the want of connective strands of the eggs with the germ area places the ovaries especially beside those of the Cicadellinæ. The genital armature of the Terebrantia is found in the Orthoptera and Phytophthira.

In anatomical respects, therefore, the Physapoda come nearer the Homoptera than the Orthoptera s. l. There is also a series of biological facts which strengthen still further the connection of these insects with the Homoptera. First, I would recall that the Physapoda with their nymph and pronymph stages, in which they take no nourishment, exhibit a very similar transformation to that which is known to take place in Coccid males. The parthenogenesis of Thrips is not Orthopteroid, but a method of reproduction which is peculiar chiefly to the Phytophthira. The frequent

occurrence of apterous species without rudiments of wings, the condition that one sex is so frequently winged while the other is wingless, that among the normally winged species there appear individuals with reduced wings, that the latter phenomenon occurs especially toward autumn; all these are occurrences which take place to a considerable degree in the Phytophthira.

The manner of nourishment of Thrips, their life in larval colonies, the rapid and successive development of each generation, the sucking of plant roots by the larvæ, the periodical swarming of multitudes of the winged species give to Thrips throughout an Aphid-like character.

Therefore we can not doubt that we must separate the Physapoda from the Orthoptera s. l., but we must still determine whether we may incorporate them into the Rhynchota. If we maintain the division of the insects into eight orders (Thysanura, Orthoptera s. l., Rhynchota, Neuroptera, Lepidoptera, Diptera, Hymenoptera, and Coleoptera) and include in these orders the aberrant Siphonaptera, Mallophaga, Strepsiptera, the first in the Diptera, the others in the Orthoptera and Coleoptera, then we must also consider the Physapoda as Rhynchota and divide the Rhynchota into Heteroptera, Homoptera, and Physapoda.

But if, according to Brauer's classification, we break up the conglomeration of the Orthoptera s. l. into several orders of insects equivalent to the well-defined Coleoptera, Hymenoptera, Lepidoptera, Diptera, and Neuroptera, and also consider the aberrant Siphonaptera as a single order, just as the Bryozoa, Echinorhyncha, etc., represent aberrant types of worms, then there is no necessity for destroying the unity of the type of the Rhynchota by the incorporation of the Physapoda, but we can erect for Thrips a new order, the phyllogenetic value of which we find in that they have branched off from the line of the Orthoptera-Homoptera-Heteroptera where the Orthopteroid characters of the Homoptera are not entirely suppressed, and that they exhibit special mouth parts which morphologically still remain somewhat Orthopteroid, but functionally are quite Rhynchotoid. The Mallophaga with their Rhynchota-like nervous system and their four malpighian vessels must have branched off before the Physapoda. Their special connection with the Physapoda arises from the form of the tracheal stigmata in the development of the thorax in which the metanotum, as in the Physapoda, is larger than the mesonotum in contrast with all Rhynchota and Orthoptera. If we collect the Mallophaga, Psocidæ, and Termitidæ as Corrodentia with Brauer, then we must place Physapoda in the system between Corrodentia and Rhynchota.

COLLECTION OF THYSANOPTERA.

As the life habits of species of this order differ very greatly, the methods of collection must be varied according to the species. The majority of these insects are to be found in flowers, grass, etc.; many are found exclusively in turf or near the surface of the ground; others are taken most commonly under the bark of trees, on foliage, etc.

For the grass-inhabiting species, I have found a short-handled sweeping net, made of fine muslin, most serviceable. Other cloths may be used, but the texture must be considerably finer than that of cheese cloth or many of the smaller species can easily pass through it and escape. As a white background greatly facilitates the observation of these small creatures, the contents of the net may be carefully examined by slowly turning it inside out without emptying it or the net may be emptied and the contents be examined upon a sheet of white paper carried for the purpose. Small phials serve as convenient recep-

tacles for the collections from various plants or other sources and thus they may be kept separate if desired. The most convenient method yet found for catching these lively little animals is to moisten a fine camel's-hair brush and place it directly upon the escaping actively jumping or flying forms. Those that are more sluggish in their movements can be easily lifted upon the point of the brush and transferred to the phial, which may be stoppered with a cork or wad of cotton. A label giving such data as it is desired to preserve may be placed in the phial or attached to the outside and a bit of the food plant may well be placed inside with the insects. In this bottle they may be kept alive for some time, if it is not convenient to preserve them at once.

Uzel recommends for collection from flowers, inclosing the flower head, insects and all, in a four-cornered paper bag, folding the upper edge over twice and fastening with a pin. Flowers of only one sort should be placed in a bag. The contents of the bags are examined at home upon a sheet of white paper and the escaping creatures captured with the aid of a fine brush dipped in alcohol. In winter, dried flowers and grass stems yield many hibernating forms.

Tree-inhabiting species may be found by beating over a white surface, or foliage may be collected and sifted by means of a fine beetle sieve, which is a great convenience for this work. In this way may be found also many species inhabiting turf, moss, fallen foliage, or decaying bark. The sifting may be done directly over white paper or the siftings collected by means of a fine bag fastened around the sieve and examined at the collector's leisure at home. Some species are known to inhabit certain oak galls and probably other galls will be found to shelter other species. The gall is, as a rule, the work of some other insect which the Thrips has appropriated for its home, but in Australia some galls are said to be formed by the Thrips themselves. Both Uzel and Jordan state that many inhabit fungi, but I have not yet found any in such a location.

PRESERVATION AND MOUNTING.

Various methods of preserving these tiny insects have been tried. Being so small that it is impossible to study them without the aid of a compound microscope, the method has been sought for which would best preserve the natural form and color of the insect and the most satisfactory results have been obtained in the following simple way:

The specimens to be mounted, having been brought into the laboratory alive in small bottles, are quickly killed, and at the same time cleared, by dropping them directly into xylol in which they are left for about an hour. They may then be mounted directly in balsam dissolved in xylol without danger of cloudiness resulting from moisture in the insect body. The mounts are clear, natural colors are well preserved, and when dried they are permanent and always available

for study. Working with such small insects, it is difficult to arrange them satisfactorily upon the slide, but with patience and care this can be accomplished fairly well. The wings should be spread, and this condition has, as a rule, been most easily obtained by transferring the insect from the xylol to the center of a clean slide, and then teasing the wings out to the desired position by means of a fine bristle. The balsam is then placed on the cover and gently lowered onto the insect. As the balsam spreads it tends to carry out the wings, legs, and antennæ so that they are in a position for study. It is a convenience in study to have two specimens on the same slide, one being dorsal, the other ventral side up. Specimens of different species should not be placed upon the same slide. If it is desired to keep a large number of duplicates, it is not, perhaps, advisable to mount them all in this way, as they can be fairly well preserved by placing the living insects directly in about 80 per cent alcohol. Alcohol is, however, liable, or even likely, to cause an abnormal distension of the body, especially with Tubulifera, and if some of these distended specimens are afterwards mounted permanently for study it will be found that their general appearance has become so changed that the species is scarcely recognizable. For this reason I can recommend alcohol only for duplicates of well known species and never for undescribed material.

While balsam mounts, made as described, seem to be best for preserving the general natural appearance of the insect, mounts made in another way are more useful for study of the chitinous structure. Everything but the chitin is dissolved by allowing the specimen to mascerate for from twenty-four to thirty-six hours in a cold 10 per cent solution of caustic potash, or by boiling for a few minutes in a little of the same solution. When thoroughly cleared the specimen may be mounted directly in glycerin, or washed in water, dehydrated in alcohol followed by xylol, and then mounted in balsam. Such mounts can be examined under high-power lenses and reveal many fine details of chitinous structure which can not be seen in ordinary mounts.

A few words in regard to glycerin mounts may save some one such disappointment and loss as my experience with them has caused me. During one summer quite a large number of mounts were made by placing the insect directly into glycerin contained in a low cell, made either of white zinc cement or hard glycerin jelly, the cover glass being carefully sealed on with the white zinc cement in each case. These mounts were beautifully clear at first and were placed aside for study during the winter. When examined again after a few months they were found to be ruined and worthless. Nearly every specimen was more or less thickly covered, especially around the spiracles and thin membranous areas, with dense clusters of white, needle-like

crystals, many of which were also floating through the glycerin. As a result these slides, containing most of the results of a summer's collecting, had to be thrown away. The exact composition of the crystals was not determined, but it is supposed that they were mostly phosphates which had been dissolved in the juices of the insect's body. As the juices were gradually drawn out, the phosphatic salts, not being soluble in the glycerin, were deposited as the white crystals.

There are still other objections to glycerin as a mounting medium for Thysanoptera, though it may be all right for other insects. The dark pigment of the eyes is frequently dissolved out by glycerin, and spreads all through the head, suffusing it with a dark color, which obscures all details in that region. Furthermore, glycerin does not preserve the tissues of the body for a very long time. They gradually go to pieces, the segments spread apart, and the mount becomes worthless in the course of a few years. Of course this objection to glycerin does apply to the mounting of chitin which has been cleared from all soft tissues by treatment with caustic potash solution, as chitin is unaffected by glycerin.

EXTERNAL ANATOMY.

INTEGUMENT.

Adult.—The chitinous skeleton of these insects is quite firm. The body wall is made up of strongly chitinized, rigid plates joined together by thin and very flexible membranes. The texture of the plates appears usually to be quite uniform in different parts of the same specimen. In the head, especially, several of them are so smoothly joined that no sutures are visible. The thin connecting membrane may be smooth and of a uniform thickness, or, as in many parts of the Tubulifera, it may show a peculiar structure in the nature of regular, distinct, very minute, plate-like thickenings, varying in form but often circular or hexagonal, giving a decidedly granular appearance to the area.

The chitin is frequently thrown into more or less distinct folds or ridges, most frequently transverse in direction, but often branching and running together to form a reticulated structure. The back of the head and the pronotum are most frequently marked in this way. Sometimes the ridges become very thick and pronounced, and form a regular network over the surface so conspicuous as to be of use in classification (*Heliothrips*, *Parthenothrips*, see Plate VI, fig. 64). This reticulation may extend over the whole outer surface of the body, legs, and even the fore wings, but always seems to be heaviest upon the head and pronotum. It is not known to occur in the Æolothripidæ, but is found in several species of Thripidæ, and I have discovered it in an undescribed species of Phlœothripidæ.

In certain parts of the body there are found invaginations of the chitinous, external skeleton serving as advantageous points for the attachment of muscles. These can best be seen on the meso and metasternal plates of winged species of Thripidæ, and are darker than the plates in color. Many species show a narrow, transverse line across the second to seventh dorsal abdominal plates near the anterior edge of each. This dark line is caused by a chitinous, ridge-like thickening forming an arch on the inside of each of these plates.

The chitin of the skeleton is rarely entirely unpigmented. Pigmentation may take place in the cuticle itself, when the color is usually gray, yellow, brown, or black, or color may appear from pigments deposited in the hypodermis or fat-body. Such deposits are usually very irregular and of a yellow, red, or purple color. Pigments are frequently present in both places in the same individual. Metallic colors do not occur.

Larva.—The chitin of the larva is much less firm than that of the adult, and there is scarcely any differentiation in texture or structure between the plates and connecting membranes. The surface is not reticulated, but is usually considerably wrinkled transversely and roughened, though sometimes it is quite smooth.

Pigments are rarely present in the chitin of the larva, and when they do occur the colors seem to be limited to gray, yellow, or brown. Larvæ are usually of yellow or red color, but these colors are due to hypodermal or fat-body pigments, and to some extent, perhaps, to the body fluids.

Pupa.—The delicacy of the chitinous covering of the early stages can be seen during the period of transformation. It is then thin, smooth, and often shining. The cuticle forms a delicate sheath around the wings, antennæ, and legs, and toward the end of this stage can be plainly seen separated from the body of the inclosed adult.

Integumental appendages.—These are present in the form of hairs, bristles, or spines which are variously modified. They are frequently borne upon small warts or tubercles which can be most distinctly seen upon the cheeks of many Tubulifera. The membranes of the wings are thickly set with microscopic hairs, usually either darker than the membrane itself or sharing its color. In some species (*Sericothrips*, various species) the abdomen is also thickly set with microscopic hairs, giving it a sleek, velvety appearance, and whorls of similar minute hairs often mark the antennal segments. The posterior fringes of the wings are always composed of long slender hairs, usually more or less spiral or wavy in appearance and inserted either directly into the edge of the wing (Tubulifera) or attached by a joint to a fixed base upon the edge (Terebrantia). This joint allows of motion only in the plane of the wing and toward its tip; it facilitates the folding of the hairs into line with the edge of the wing when the latter is brought to rest.

In nearly all species numerous short, small spines are borne upon the various parts, especially upon the prothorax, legs, and antennæ. Larger and more conspicuous spines or bristles mark especially the exposed parts of the body such as the vertex of the head, the angles of the prothorax, the veins of the wings in the Terebrantia, and the last two or three segments of the abdomen. Special modifications of these larger spines are found in many adult Tubulifera in the form of hairs which have usually a slender shaft and at the tip are roundly knobbed or irregularly funnel-shaped, though sometimes they are short and cut off squarely at the tip where they are fully as large as at their base.

Larvæ and pupæ of both suborders, in many cases, bear such knobbed or funnel hairs which, when present in the pupæ, are even longer and more slender than in the larvæ. The spines in many cases are placed in quite regular segmental rows, both in transverse and longitudinal directions.

HEAD.

The form of the head is peculiar and extremely variable. (See figs. 4, 14, 27, 55, 93, 107, etc.) But while this variation is great between different species, the proportion of length to breadth in the same species is very constant. The different sclerites forming the head are so completely fused as to be indistinguishable and we can therefore designate the regions of the head only in a general way. The dorsal portion back of the eyes is called the occiput, that between the eyes and extending forward to the bases of the antennæ is the vertex, between the bases of the antennæ and the attachment of the mouth cone on the ventral side is the frons, while the sides of the head are called the cheeks (genæ of other orders). The usual appendages of the insect head are present and will be considered separately.

Antennæ.—These are inserted upon the extreme front of the head and stand quite closely together upon the front margin between the eyes. They are always much longer than the head and may be two or three times as long. The number of segments is a character of much importance in classification and varies from six to nine. The form of the segments ranges from cylindrical to almost spherical, and this character is also of importance in classification. The spines upon the segments become more numerous as the apex is approached, and on the intermediate segments are mostly borne upon the apical half of each. The Æolothripidæ lack the specialized form and arrangement of the spines which is found in Thripidæ; their antennæ are quite uniformly clothed with short hairs or bristles. In the Thripidæ this general hairiness is lost, except in those species having whorls of hairs around intermediate segments, while a few much longer and usually more conspicuous spines are developed. The antennal spines of Phlœothripidæ resemble in a general way those of Thripidæ. In both

these families certain spines seem to have undergone much modification and to have become specialized as sense organs of some particular sort. (See Plate XI, figs. 123, 124.) They are larger than the unspecialized spines, thin walled and almost transparent, and usually end in a blunt point. In some species they are quite prominent, but as a rule are inconspicuous and require a careful adjustment of the light to be clearly seen. They are always simple in Phlœothripidæ and are usually borne upon segments three to five, sometimes three to seven.

In the Thripidæ similar structures are found, but they have undergone even greater specialization in most cases. In a few genera (*Chirothrips*, *Limothrips*, *Aptinothrips*, and *Parthenothrips*) they are simple and stand singly, one to a segment, upon the outer angles of segments three, four, and sometimes five, and upon the inner side at about the middle of six. In most cases, however, it appears that two of these specialized spines have approached and united at their base, so that we find upon the upper side of segment three and the under side of four, near their tips, a peculiar crescentic organ having the same apparent structure as the specialized spines just described and borne upon a small stalk standing in a clear, membranous area. (Plate XI, fig. 123.) In some cases these organs are shaped much like the horns of cattle and are curved in two directions, being curved forward and also toward the axis of the antenna. The fifth segment sometimes bears a simple spine and another one is also well developed upon the inner side of the sixth. The function of these structures is uncertain, but they are usually called sense cones.

In the Æolothripidæ an entirely different type of sense organ is found, though the two may possibly have much the same function. Upon the underside of segments three and four are narrow, much elongated longitudinally, thin, membranous areas, situated upon the outer half of each segment and a very small round spot of similar structure is similarly placed near the tip of segment five. (Plate XI, fig. 122.) These membranous areas strongly suggest an auditory function, but this is, perhaps, only a possibility.

Abnormal antennæ are not uncommon, and one or both may be deformed. The most common variation is in the line of a reduction in the number of segments through the fusion of two or more of the apical ones. Such deformed antennæ may not be shorter than the normal ones, but there is usually some reduction in length. In one case, at least (*Aptinothrips rufus* var. *connatticornis*), there occurs a regular and apparently normal fusion of the two segments constituting the style of the typical form with the sixth segment (Plate V, figs. 52, 54), which in this case is considered as a varietal distinction. An increase in the number of segments above the normal, by a division of one or more, is not known.

The antennæ are carried extended forward in front of the head, and

are not normally laid back along the body when at rest. In the Terebrantia the first two segments are usually markedly broader than the others.

Larval antennæ vary considerably from those of adults. The number of segments is constantly smaller, and the form is generally changed. Sense cones are not present, and the arrangement of spines is quite different from that in the adult.

ORGANS OF VISION.

Eyes.—Adult Thrips possess faceted eyes, which are borne upon the front angles of the head and extend downward onto the frons about as far as they do upward onto the vertex; rarely they are situated farther back upon the sides of the head, but still near the front. They are circular, oval, or reniform in outline. The size and number of facets varies considerably in different species, as does also the closeness of the facets to each other. The eyes are quite large, as compared with the size of the head, being together about one-half the width of the head through them. In many species, especially in Terebrantia, they are strongly protruding (*Heliothrips*, *Parthenothrips*). The individual facets are usually considerably swollen, and small hairs project from between them, thus giving the eye a peculiar resemblance to the surface of a raspberry. The cornea is quite thick, transparent, usually slightly tinged with yellow, and appears like a light-colored margin around the outside of the eye. The part of the head closely adjoining the eye is frequently also much lighter in color than the remainder of the head.

The pigmentation of the eye is dense and dark, so that, as a rule, by transmitted light the eye is entirely opaque, while by reflected light it may be red or very dark purple in color.

The eyes of larvæ are much smaller and simpler than those of the adults. They consist of but few large, separated facets, and are situated farther back upon the sides of the head.

Ocelli.—These are adult structures, and are not present in larvæ, though the pigment of the developing ocelli can sometimes be seen late in the larval stage. They are not always present, however, even in the adults. They are three in number, situated more or less closely together between the eyes on the vertex of the head, and are placed always in the form of a triangle, with its apex forward. Rarely only two ocelli are present, and it is then the front one which is wanting. Ocelli are present in all winged forms, and usually also in the short-winged forms of winged species. They are absent, however, in entirely wingless species.

MOUTH PARTS.

The mouth parts of Thrips are difficult to study, and so peculiarly modified that it has been found hard to determine their homologies.

This fact accounts largely for the many changes which have been made in the classification of this group. It is now generally admitted that their action is largely suctorial. They exhibit structures which seem to show a transition from a mandibulate to a haustellate form, and for this reason are of peculiar interest.

As a whole the mouth apparatus appears as a broad, unjointed cone attached to the extreme posterior edge of the under side of the head, being carried so far back that its attachment to the rest of the head lies largely under the pronotum (Plate X, fig. 111). The apex of the cone is usually quite sharp, but never as slender as in the Hemiptera, and lies, when at rest, in a depression of the prosternum between the fore coxæ. In many species the mouth cone is bluntly rounded. In the Terebrantia it is attached to the frons by a strongly chitinized thickening, running more or less obliquely across the under side of the head. In most species this dark thickening is nearer the left eye than the right and is connected by a similar thickening with the margin of the left eye (Plate XI, fig. 120). This connection is wanting on the right side, though a portion of the thickening still remains close to the right eye. In the Tubulifera the base of the mouth cone is much more nearly symmetrical and the connections with the eyes are entirely wanting (Plate XI, fig. 127).

Asymmetry.—So far as we can learn, Prof. H. Garman was the first to call attention to the very peculiar asymmetry which is characteristic of the mouth parts of the members of this order, and he gave a new interpretation to certain of these parts, which we believe to be correct.

Not only is the connection of the mouth cone, as a whole, with the frons asymmetrical, but also some of the individual parts of the mouth are markedly so. The most striking of these are the form of the labrum and the absence of the right mandible. These parts will be considered more in detail by themselves.

Labrum.—The labrum forms the front wall of the cone (Plate XI, figs. 120, 127). It is decidedly asymmetrical in all Thysanoptera, but especially so in the Terebrantia. It is irregularly triangular in form, does not reach to the endocranial thickening, but is attached by its broad base to the clypeus by an indistinct membranous connection. From the base it narrows to the tip, where it is more or less rounded in Terebrantia, but is quite pointed and spine-like in many Tubulifera, though bluntly rounded in others. It is drawn out much farther toward the right cheek than toward the left, and on the right side also approaches most closely to the transverse thickening. The labrum is usually abruptly darker in color than the area between its base and the transverse thickening.

Maxillæ. The mixillæ are broad, flat, and external. Like the labrum, they are wedge-shaped or triangular in general form, and they constitute the side walls of the mouth cone. They taper toward their

tips, where they are quite sharply pointed and strongly chitinized, and may reach slightly beyond the labrum. At about the middle point of the side of each maxilla is borne a two or three segmented palpus. In the Æolothripidæ this is always three segmented and geniculate; in the Thripidæ it is composed of two or three approximately equal segments and is straight, the segments being cylindrical but decreasing successively in diameter; in the Phlœothripidæ it is always two segmented and the segments are very unequal in length, the basal one being short and rounded while the second is long, slender, and cylindrical. The terminal segment is in all cases provided with a few touch bristles which are but rarely distinctly and easily visible.

Labium.—The labium is believed to be formed by the union of the second pair of maxillæ and in many insects evidence of this can be seen, but in the Thysanoptera there is no visible suture along the median line, though sometimes a deep median notch is present at the tip. It forms the hind wall of the mouth cone and is, as a rule, considerably broader at the tip than the other parts. In many species of Tubulifera especially, it is very broad and heavy at the tip, but in others it is narrowed and the whole mouth cone is then usually elongated and pointed. Standing closely together, each upon a membranous space a little to one side of the middle of the tip, are the two or four segmented, cylindrical, labial palpi. The maximum number of segments is here found also in the Æolothripidæ, and the minimum number in the Thripidæ and Phlœothripidæ. Around the tips of the labial palpi are borne a few touch bristles similar to those upon the maxillary palpi.

Within the hollow cone formed by the parts just described lie the protrusile, piercing organs of the Thysanopteran mouth. These organs are three in number and of two kinds. Their homologies have been confused by various writers.

Mandible.—This is the large, unpaired, piercing spine lying on the left side in the mouth cavity. It has been variously interpreted as epipharynx, mouth spine, etc. In the right side of the head there is no trace, or but a mere vestige, of the corresponding organ. The absence of the right mandible appears to be closely correlated to all the asymmetry of the mouth parts of these insects. The mandible consists of two parts, though these are not separated in any way. The large bulbous base appears to be mostly muscular and is attached to the endocranial thickening behind the left eye close to the angle which is made by the endocranium at this point, and about in line with the branch from this thickening running to the left eye in Terebrantia, which branch thus appears to form a strong brace. On the right side the absence of this endocranial branch is doubtless due to the non-development of the right mandible, and the labrum has grown out farther on the right side to take the place in some measure of the

wanting structures. The muscular base is short and abruptly constricted, and from this point to the tip the mandible continues as a slender, strongly chitinized spine having a very sharp point. This structure is capable of protrusion for only about one-fourth of its length, and therefore appears to be used only for piercing the outer, tougher tissues of plants. The mandible in the Tubulifera is decidedly shorter and more bent than is that in the Terebrantia.

Maxillary lobes.—This pair of piercing organs has been considered by the majority of writers as the mandibles, but such they surely are not. Dissection shows that they are attached by a movable joint to the bases of the maxillæ. Each lobe is composed of two parts: A short basal, muscular arm or lever attached to the maxilla, and at the other end united to the enlarged, muscular base of the spine which is very slender and strongly chitinized. These spines are longer and more slender than the mandible and are developed alike on each side. When retracted into the mouth, the basal arm or lever extends obliquely forward so that the lever forms an acute angle with the spine, which then reaches just to the mouth, but when protruded the lever is brought down toward the mouth so as to straighten this joint, and the spine is thus thrust out from the mouth opening to a considerable distance. As these spines are more slender and protrude farther from the mouth than does the mandible, it appears probable that the latter is used to start the puncture through the hard, tough outer tissues, while the weaker lobes of the maxillæ, penetrating deeper through this opening, reach into the inner tissues. Some writers have stated that the three spines are hollow and used as suction tubes, but I have not found this to be the case in the species examined.

There is a marked difference in length of the maxillary lobes in the two suborders. In the Tubulifera they are extremely long, and when retracted curve far forward under the eyes, while in the Terebrantia the bend of the lobes scarcely reaches beyond the transverse thickening. In the Tubulifera these lobes are altogether longer than the entire head and can be protruded in many species as far as the hind edge of the mesosternum.

Other mouth structures.—Attached to the inner surface of the labium are certain other chitinized structures hard to describe and of uncertain homology, but considered by some as an hypopharynx.

Larvæ.—The mouth parts of the larva are much the same as those of the adult, though weaker and less strongly chitinized. The chitin of these structures is shed at each molt, and may then be seen connected with the cast-off skin.

Movements of mouth parts.—The parts forming the external wall of the mouth cone are not free, being united by a membranous connection along their sides. At the tip of the cone there is a small opening. It thus appears that structurally these insects are incapable of biting or

chewing their food to any degree, though it has been stated that particles of leaf tissue have been detected in their excrement. This may be accounted for by the fact that the mouth parts are quite strongly chitinized at their tips, and so may serve, to some extent, to rasp or tear the tissues, small particles of which may be drawn into the alimentary canal with the sap.

THORAX.

(Plate XI, figs. 116–119, 125–127.)

The thorax is composed of three distinct segments, each of which is well developed. The prothorax is separated from the mesothorax by a deep constriction and is freely movable. The other thoracic segments are closely grown together and form what is conveniently called the pterothorax. The larval thorax shows no particular chitinized plates and its whole structure and the arrangement and development of the spines have been but little studied.

Most previous descriptions of the thoracic structure of these insects have been very brief. Unfortunately Dr. Uzel has given the entire anatomical part of his monograph in Hungarian, and therefore his description of the thorax has not been available. It is evident that there is considerable variation in the thoracic structures in different species, and it may be that when carefully worked out these parts will be found to have considerable importance in classification, whereas they have not been used in this way heretofore. A general description of the parts of the thorax is difficult to give and must be subject to much modification in many species as the homologies of some parts are not well established.

Prothorax.—This segment is as wide or wider than the head and varies much in its proportions and form. It is rarely much longer than wide, usually exceeds the mesothorax in length, and in most cases approximately equals the metathorax. The form in the Terebrantia is usually more or less rectangular, with the sides and hind edge especially somewhat rounded. This form is also found in some Tubulifera, but as a rule among them the thorax is trapezoidal, being much wider at the hind edge than at the front. This trapezoidal form appears to be closely related to the development of the fore legs, since in the genus *Chirothrips* where the fore legs are extremely thickened there is found the same form of prothorax as in the Tubuliferan genera where the fore femora are also enlarged.

The pronotum is strongly chitinized. In the Thripidæ it is usually more or less transversely striated and often bears numerous small spines. In the other families it is generally smooth.

In most Thysanoptera the prothorax bears long conspicuous spines, the number and arrangement of which are much used in classification. These stand usually around the outside of the pronotum—one or two

at each angle and a pair on each of the transverse margins, and in some species one in the middle of each side. The maximum number is therefore twelve. When only one or two pairs are present they are at the hind angles. The form and size of these spines is also variable. They may be quite short and inconspicuous or nearly as long as the protonum itself. In many Plœothripidæ they are knobbed or funnel shaped at the tips.

In a number of species of Tubulifera, a division of the pronotum into plates near the hind angles has been observed. Two triangular plates coming up from behind the middle on the side and at about the hind angles meet at a point considerably within the margin and above the fore coxæ. The prosternum is less strongly chitinized than the pronotum and at about the middle of the fore edge is often indented to accommodate the mouth cone. The insertions of the fore coxæ are at the hind angles and the distance between them depends upon the width of the hind edge of the prothorax. In some species the prosternum appears to be entirely membranous, while in others there are two small plates between the coxæ near the hind margin. The episternum and epimeron are more easily distinguishable in most Tubulifera than in Terebrantia.

Mesothorax.—The mesothorax is a broad, short segment, often the broadest of the body. The mesonotum is shorter than the mesosternum, though the latter approximately equals the metasternum as a rule, in consequence of which the division between the meso and metathoracic segments is oblique. The mesoscutum is usually a rather hexagonal plate, somewhat broader than long, and has thickened edges which are bent inward and used for the attachment of muscles, as is shown by cross sections of this region of the body. A narrow prescutum can be easily distinguished in some species, though in others it appears to be closely fused with the scutum. On each side of the scutum is a membranous area upon which the fore wings are inserted, at the bases of which there are chitinous thickenings for the attachment of muscles and also serving as pivotal points. A small, curved, triangular tegula is present in many, if not all, Terebrantia. Upon its broad edge, next the base of the wing, it is furnished, in Æolothrips, with a row of five or six small, stout spines which point directly toward the base of the wing, upon which, very near its base, there stands a somewhat larger, curved spine which, when the wings are extended in flight, points toward and would appear to engage some one of those upon the tegula. This is a peculiar and interesting structure the purpose of which can only be conjectured. In Thripidæ the tegula is present, but I have found no species having the spines fully developed, though little knobs or vestiges of such structures are present in some cases. The tegula is not always distinctly visible. At each anterior angle of the mesothorax there is a larger or smaller spiracle, which is

usually much elongated and narrow in Terebrantia, while in Tubulifera it is more rounded. In front of the spiracle a narrow plate extends up over the shoulder and meets the mesoscutum. This plate in some cases is only an upturned portion of the broad mesosternum, but in others is distinctly separated therefrom. This plate may be called the episternum, either separate or fused with the mesosternum. Behind the spiracle and below the attachment of the fore wings, there are one or two quite broad skeletal pieces which are rather triangular in shape. The mesosternum usually covers the whole ventral surface of the segment and its edges bend upward at the sides (e. g., *Heliothrips*, see Plate XI, fig. 119). In some species, however, it is an hexagonal plate similar to the mesoscutum and but little larger, while the episternal and epimeral plates are elongated and meet the sternum upon the ventral surface. Upon the median line of the sternum there is in all species, though very weak in the wingless ones, a quite deep chitinous invagination more or less forked and serving for the attachment of strong muscles (Plate XI, figs. 117, 119, 127). These endothoracic structures are plainly visible in most species. The middle legs are inserted far apart at the very hind angles of the mesosternum.

Metathorax. This segment is usually slightly narrower than the preceding and generally tapers slightly to the base of the abdomen. Its dorsal plates are two, usually distinctly separated: a scutum and a scutellum. On each side of these a membranous strip continuing that from the mesothorax, extends backward to the base of the abdomen. The hind wings are attached quite close to the fore wings and in a similar manner. Near the bases of the hind wings lies in Tubulifera a very distinct rounded or oval spiracle. This spiracle is present and visible in many (Uzel says "all") Terebrantia, but I have been unable to find it in some species; in others it is extremely small and apparently functionless, while in still others it can be distinctly seen. The metasternum is broad and its edges curve upward around the sides of the body. At the front edge of this side lies a narrow triangular plate, the meta-episternum, while the meta-epimeron is here a narrow elongated plate lying above and close to the upturned edge of the sternum. The metasternum bears also a prominent endothoracic structure in the middle and the edges of the plates are often bent inward and thickened. The attachment of the abdomen is so oblique that the hind coxæ lie beneath the first abdominal segment. The hind coxæ are well separated and the sternum usually projects back between them as a distinct lobe or conical protuberance.

Variation in the structure of the pterothorax in wingless species. The pterothorax is similar in both short and long winged individuals and we may expect to find at times long winged specimens of usually short winged species. In species which are entirely wingless, however, or in those one sex of which is always wingless, a marked variation in

the structure of the pterothorax is evident in the wingless individuals (Plate XI, fig. 125). The size of the pterothorax becomes greatly reduced in such cases as no great muscular development is needed to move the legs alone and the pterothorax is, perhaps, but little larger than the prothorax. The dorsal plates of both segments lose the usual form and become rectangular and transversely broadened, extending over the membranous space which is usually present along each side. No traces of wings are present and there is no longer any place for them. As a consequence of the decrease in musculature the endothoracic structures have become very much weaker, though still plainly visible.

APPENDAGES OF THE THORAX: LEGS.

The legs of Thrips are among their most characteristic structures and can hardly be mistaken for those of any other insects, whether short and powerfully thickened or long and slender. They are composed of the usual parts of the insect leg, which may be readily distinguished. The attachments to the thorax are quite far apart and at the very hind edge of each segment. The fore legs are often shorter and thicker than the others and more specialized.

Coxa.—This basal segment is large, usually subconical and quite freely movable. The fore coxæ, especially in Phlœothripidæ, often bear a few short, very stout, sharp spines and one long spine at the outside, but aside from these spines the coxæ exhibit little that seems to be worthy of note.

Trochanter.—This is a short, small segment between the coxa and the larger femur, its line of attachment with the latter being often considerably oblique.

Femur.—This, the first prominent segment of the leg, is quite long and more or less cylindrical or fusiform. The fore pair is frequently distinguished by much greater thickness than those of the other legs, (especially in Phlœothripidæ), the enlargement taking place in the upper side of the base and diminishing toward the outer end. In *Chirothrips* the lateral surface is strongly chitinized and bent backward somewhat at the tip so as to appear almost tooth-like at that point. In thickened femora, especially, the inner side toward the base is grooved to receive the base of the tibia when the latter is closed inward, and in a few species with this kind of femur the angles here have become sharply pointed and chitinized so as to form two sharp teeth at the tip (Plate VIII, figs. 89, 90).

Tibia.—The tibia is, as a rule, about as long as the femur and more nearly cylindrical or often club-shaped in form. It is most slender near its base where it is often slightly bent. At the extremity within, in a few species, the tibia bears an erect, stout, recurved hook or tooth as it is usually called.

Tarsus. This is the most distinctive part of the leg. As a rule it is composed of two segments, though in larvæ and the fore tarsi of many species but one is present. The division between the two is oblique so that the under surface of the first segment is longer than the upper. Both segments are more or less cylindrical. The last segment terminates in a cup-shaped or hoof-like end which has been mistaken sometimes for a third tarsal segment. Upon the inner side of the fore tarsi are found structures which are nearly always characteristic of families. The Æolothripidæ, in both sexes and it is stated also in the pupal stage, bear upon the tarsus a peculiar hook-like structure the function of which is not understood. (See Plate I, fig. 9.) The finger-like hook is bent back upon itself, pointing toward the base of the tarsus and almost touches the point of a short, stout spine standing erect at its tip. In many species of Phlœothripidæ, though not in all, there is on the inner side of the tarsus a more or less stout tooth which stands nearly erect and is slightly recurved at its tip, and when this tooth is strongly developed, the tarsus, so far as is known, has only one segment. The development of this tooth seems also to be in proportion to the degree of development of the fore femur and its function appears to be to act as a hook in giving a firm hold and thus assisting the little creature in crawling through small places. Some Phlœothripidæ show no traces of such a tooth and all grades of development can be found in different members of this family. Both sexes usually possess such a tooth, though that of the male is sometimes much stouter than that of the female. In the Thripidæ the tarsi are simple, without either of these structures in nearly all species, only a few having a small tooth.

The tarsi are usually said to be clawless, but I do not consider this to be always the case, for some species have one and some two distinct, apparently movable claws on the sides near the end.

Spines.—Each segment of the leg may bear numerous spines, and some of these may be particularly well developed and worthy of note. In many Tubulifera there is upon the inner and lower side of the femur near its base a slender spine very much longer than any of the others. The hind tibia in most species of Thripidæ is furnished with a row of stout spines along the inner side and in many species a pair of similarly stout spines is borne at the tip of each tibia. Other specialized spines are sometimes found.

Bladder.—This structure, so remarkable and characteristic as to suggest the name Physopoda for the order, is protrusile from the end of the last tarsal segment. It is found in all species and in both adults and young, but its structure and action does not seem to be quite the same in the mature and immature stages.

As has been said, the end of the adult tarsus is cup-shaped. The wall of the cup is firm and in some parts, especially the underside,

strongly chitinized. Into the mouth of this cup is fitted a very delicate, protrusile, membranous lobe or bladder. When the foot is raised or at rest, the bladder is wholly withdrawn into the end segment and becomes invisible, as is the case in a majority of mounted specimens. The end of the tarsus is now blunt and flat and often seems to be minutely haired. The bladder is, however, always protruded and brought into action when the tarsus is put down or brought into contact with an object. The membrane is then pushed out and forms a lobe, larger in many cases than the cup portion which had previously wholly contained it. The mechanism of this complicated structure is very interesting but difficult to study. It has, however, been worked out, partially at least, by both Jordan and Uzel. The following paragraph on this point is gathered from Jordan's description and my own observations:

Bladder mechanism.—A strong chitinous rod, attached to muscles in the tibia, runs out through the tarsus and ends in the broadened, heavily chitinized under surface of the cup. The end of the plate is drawn out into weak cords running to the outer parts of the cup wall. Opposite the chitinous rod lies a double fork provided with a joint. The fork is cut short at a chitinous rod lying in the terminal segment of the tarsus and is movably joined thereto. Both arms of the fork are connected with the chitinous rod at their base by a tendon. Between the fork and the terminal plate of the chitinous rod the wall of the cup is usually thin and quite transparent, but in Phlœothripidæ especially it is quite strongly chitinized and opaque. Looking down upon a foot that is inactive (bladder retracted) so that the chitinous rod lies along its middle line, the end appears more or less pear-shaped and small. Upon the surface lies the terminal enlargement of the rod, while the double fork occupies the sides. Between the tips of the fork the extremity appears folded in toward the middle. When the foot is brought into action the chitinous rod is drawn back somewhat, so that the attached fork is erected and spread out. The previously invisible bladder is now thrust out from the end of the tarsus. The ends of the fork and the chitinous rod continue into the bladder wall as fine rays. The bladder is elastic and very mobile, easily accommodating its shape to the surface upon which it rests. Looking at a larval tarsus from the side, the chitinous rod is seen to run obliquely from the middle of the tibia to the under wall of the cup. Here it appears to end suddenly without being broadened into a plate as in the adult; still the end of the rod is continued into the wall of the cup as fine rays. The dorsal part of the cup is occupied by a curved claw, the basal part of which is attached to a sort of bracket-like thickening of the wall of that part of the end segment at the base of the cup. Furthermore, the base of the claw is united to the chitinous rod by a sinew, and above the extremity of the claw the tarsus is drawn out into a membranous, longitudinally folded lobe. When viewed from

above, it is seen that the bases of the claws are strongly broadened within and somewhat less so without, and that the inner prolongations touch and are flexibly joined together. Both claws are supported upon the bracket-like ring at the base of the cup, while the folded membranous wall reaches beyond the claws. The chitinous rod unites near the support with the two tendons coming from the outer projections of the claws. When the bladder is brought into an active condition, the claws bend out from each other and the folded portion between them spreads out, while the distal portion, unseen in the inactive foot, becomes pushed out as the bladder. By a proximal pull upon the chitinous rod the tendons are drawn back and the claws thereby are spread out, moving around the bracket-like support with which they are connected as on a pivot. As the claws are grown together with the folded lobe, the lobe must be unfolded, but this does not explain how the membranous lobe can be protruded as a swollen bladder. If a swollen bladder be pricked or ruptured the blood pours out and the bladder collapses quickly. We must therefore conclude that blood pressure, acting with the mechanism just described, is largely instrumental in the protrusion of the bladders.

Other organs of doubtful function.—In the basal segment of the tarsus or the extremity of the tibia there has been found in a few European species a small, pear-shaped organ which has been considered as a gland, and some have thought this the structure which produced the swelling of the bladders, but as this supposed gland is much smaller than the bladder which it is supposed to fill, this can not be, and its function remains still problematical.

Near the line of union of the femur with the trochanter, Trybom has found in certain Phœothripidæ an organ or a group of organs which suggest to him the auditory organ on the base of the tibia in some Locustidæ. Trybom speaks of this structure as an elongated, thinly chitinized area, almost transparent. The areas are found on the side of the base of each femur near the line of its union with the trochanter. They are variable in shape and may be different on the opposite legs of the same pair. In each light area is a row of round structures having a dark point in the center of each.

These peculiar structures are small and easily overlooked, but Trybom has seen them in many species of Terebrantia as well as Tubulifera, and the writer has seen them in every species in his own collection. It appears, therefore, that they are always present, but as to their function we can only guess.

WINGS.

The wings of Thysanoptera are no less characteristic than are their feet. To be sure each character shown by them may be found in the wings of some other group of insects; nevertheless the combination of characters found here is unique. They are long, slender, membranous,

fringed, and not folded; they have few veins, and upon the hind edge of the base of each there is a usually distinct lobe or scale. The fore and hind wings are formed quite similarly. When at rest, the wings are folded back flat upon the abdomen, the fore wing covering the hind one completely and the pairs lying parallel in the Terebrantia, while in the Tubulifera the wings all overlap at their tips so that the full surface of only one can be seen when they are at rest. The wings are usually about as long as, though sometimes much longer than, the abdomen, but in many Tubulifera they are shorter. The wings of Æolothripidæ are proportionally the broadest in the order, being in the middle about one-seventh as broad as their length. Those of Thripidæ are much more slender, ranging from one-tenth in the fore wing of *Parthenothrips* to about one-twenty-sixth in that of some *Sericothrips;* the average in the species of this family known to me is about one-fifteenth. Three general types of wing are found in the order, each of which is characteristic of a family.

Family types.—Æolothripidæ possess wings which are comparatively broad, as we have seen. Their breadth continues nearly to their tips, where they are broadly rounded. (Plate I, fig. 2.) The hind wings resemble the fore wings closely in general outline and size.

The wings of Thripidæ are distinctly different from the preceding. Besides being much more slender, they taper from base to tip, where they are sharply pointed, the whole wing being usually slightly curved so as to be quite sabre-shaped. (Plate II, figs. 16, 23.) The fore wing of *Parthenothrips* approaches most closely that of Æolothrips, being broad and straight but pointed instead of rounded at the tip, and the venation is very different. The hind wings are somewhat shorter and narrower than the fore wings.

The third type of wing (Plate VII, fig. 75), found in the Phlœothripidæ, resembles that of Æolothrips in being broad and rounded at the end. The hind wing is also similar in size and form to the fore wing. In some species the wing is narrowed in the middle so that it resembles somewhat a shoe sole. Other characters, as venation, fringing, etc., separate them very decidedly from the Æolothripidæ.

Venation.—The venation is even more characteristic of the families than the form of the wings. In the Æolothripidæ, the fore wings show the most complex venation found in the order. They are entirely bounded by a strong ring vein and pierced by two longitudinal veins extending from the base to near the tip, where they bend outward and join the ring vein. Four or five cross veins are also present, two uniting each long vein with the ring vein at about the first and second thirds of the wing and one cross vein uniting the long veins before the middle. The hind wings have no fully developed veins.

In the Thripidæ the veins are much less prominent, except in *Parthenothrips.* One or two longitudinal veins are present, but cross veins have very nearly disappeared, though vestiges of most of those

found in Æolothripidæ can sometimes be observed in this family. The hind wings have always one longitudinal vein, but no ring or cross veins.

The wings of Phlœothripidæ are marked by the absence of veins. In both fore and hind wings alike there is but a partial development of one median longitudinal vein. This is quite strong and marked at the base, but rarely reaches to the middle of the wing before it disappears. There is no trace of a ring vein.

Fringing.—As a rule, fringes of long, slender hairs are borne upon both margins of the wing and so make up for the narrowness of the membrane. The hind fringe is always present, but the fore fringe is nearly absent in Æolothripidæ, always present in Phlœothripidæ, and more or less fully developed in Thripidæ. The front fringe consists of a single row of hairs which, when fully developed, are stouter in Terebrantia than those upon the hind edge, but in Phlœothripidæ they are similarly developed on both edges. In some Thripidæ the front fringe is vestigial, being very weak and sparse, or it may be entirely absent. On the hind wings the front fringes are more uniformly well developed than upon the fore wings, and both fringes are single. The hind fringe of the fore wing in Terebrantia consists of two rows of hairs so placed that they stand, when in flight, at different angles to the edge of the wing and thus by crossing give mutual support and form a mesh-work which is more strongly resistant to the air. The hind fringe hairs of both wings in Terebrantia are more or less wavy or spiral in form while those of the front fringes are straight, as are also both fringes in the Tubulifera. The hind fringes of both wings of Tubulifera are single except that near the end of the fore wing the fringe is double for a short distance. The length of the hind fringes is from two to seven times the breadth in the middle of the wing. Fringes are wanting near the base of the wings.

The method of insertion of the fringes differs in the suborders and is of interest. In the wings of Tubulifera the hairs are inserted directly for some distance into the membrane of the wing, where they gradually disappear. They are so flexible near the base that they can be bent back along the edge when the wings are folded at rest. In Terebrantia, however, the fringe hairs are borne upon small supporting bases on the edge of the wing and are in general stiffer than are those of Phlœothripidæ. One row of those upon the hind margin is attached differently from the other. The hairs stand upon small, conical, basal enlargements, to which they are attached by a joint so as to allow an easy folding of the long hairs toward the tip. Toward the base of the wing, however, the side of the somewhat conical support is drawn out into a point, which prevents the folding of the hairs toward the base and keeps them at nearly right angles to the edge of the wing during flight.

Spines upon wings.—In the Terebrantia the entire upper surface of the wing is thickly set with microscopic spines which are wanting in Tubulifera. Besides these there are usually borne along the longitudinal and costal veins some larger, prominent spines, which vary in number, size, and arrangement sufficiently to give in many species of the Thripidæ characters of specific and generic value. Those borne upon the costa appear intermixed with the fringe hairs, though really they are not in the same plane. Their development seems to be in inverse proportion to that of the fringe, so that when the latter is strongly developed the costal spines are not larger than those upon the other veins, but when the fringe is weak or absent the costal spines develop greatly and to some extent replace it.

In Æolothripidæ the spines upon the veins are always quite small, while the front fringe of the fore wing is wanting. In Phlœothripidæ there are usually three stout, erect spines near the base of the vein in the fore wing.

Taking flight.—It has been frequently noticed and mentioned that many of these insects throw up the end of the abdomen, much as do the rove beetles (Staphylinidæ), as though threatening to sting. This movement is made to assist in the proper spreading of the wings for flight. When at rest, the fringe hairs lie along the hind edges of the wings and are more or less interlaced. As the abdomen is raised, the wings are drawn down over its sides in such a manner as to make it appear that the spines upon the sides of the abdominal segments are used to some extent as a comb by means of which the hairs are straightened out and put in their proper position. This operation often has to be repeated several times before the wings are brought into a condition for successful flight. The power of springing, possessed by some species, also seems to be of assistance in taking flight. These statements apply only to Terebrantia, however, no observations having been made upon Tubulifera.

Coordination of the wings.—This is accomplished in a manner strongly suggestive of the Hymenoptera, though the structures concerned are less highly developed. Upon the costa of the hind wing, near its base, stand about five short spines in Terebrantia and two or three in Tubulifera, which are hooked at their tips. When the wings are spread in flight these tiny hooks engage a membranous fold on the underside of the scale of the fore wing. Beyond these small hooks stands a single stouter spine which also forms a hook. From the hind angle of the scale of the fore wing proceed two long, stout spines, standing so closely together as to often appear like one, and these engage the solitary stouter hook on the hind wing. Thus united the wings move together, but as the connection is so near the bases of the wings it can not be very strong.

Reduction of the wings.—It is an interesting fact that in this order

the wings may be fully developed, reduced to short pads not reaching beyond the thorax, or even entirely absent. Intermediate conditions are rare, though I have found a few specimens in which the wings were about one-half their normal length and entirely functionless. These three conditions may occur even in the same species (*Chirothrips manicatus* Haliday). When the wings are reduced, the little pads are rounded or oval in shape and are laid closely upon the thorax. The fore pad is larger, bears a few small spines, and covers the spineless hind pad completely. No fringes are present, but the fore pad has a distinct scale. Trybom, who has made quite an extensive study of this subject (425), recognizes eight classes into which these insects may be divided according to the varying conditions of the wings.

1. Both sexes entirely wingless.
2. Males and some of the females wingless.
3. Males entirely wingless, but females with normally developed wings.
4. Long winged and wingless individuals of both sexes occur.
5. Males and a majority of females with reduced, but a number of females with normally developed wings.
6. Both sexes always short winged.
7. Long winged as well as short winged individuals of both sexes occur.
8. Both sexes always long winged.

The appearance of a long winged generation following several which have short wings is strongly suggestive of a similar condition among the Aphidæ. In at least some species of Thysanoptera where this condition obtains the summer generations develop long wings while the fall generations are almost entirely short winged, so that nearly all the hibernating females have only wing pads. Long and short winged forms commonly alternate in the same sex, but short winged and entirely wingless forms of the same sex are not known. When only one sex is wingless it is the male. Wing pads are usually rather difficult to see, but their presence or absence can be deduced from the structure of the thorax, even though they are themselves invisible.

ABDOMEN.

The form of the abdomen varies from cylindrical to elongate-ovoid. In Terebrantia the segments are nearly cylindrical in cross section, while in Tubulifera the abdomen is flattened, giving the cross section an elliptical outline. The terminal segments especially are differently formed and characteristic of the suborders. The abdomen is always composed of ten segments, of which the second to the seventh, inclusive, are similarly formed in nearly all cases, while the others are variable and bear the most distinctive characters of the abdomen.

Terebrantia.—In the Terebrantia each segment except the first and the last three is composed of a broad dorsal plate reaching to the sides, a somewhat narrower ventral plate, and one or two very narrow plates on each side connecting these. Jordan states that one of the two pleural plates comes from the ventral, the other from the dorsal plate, but the dorsal pleural plate is sometimes wanting or indistinct. The dorsal plates of segments two to seven inclusive, are usually strengthened, especially in the Terebrantia, by a chitinous ridge along the inside somewhere in the anterior third, and this appears externally as a darker, narrow stripe on these segments. The first segment has a well-developed dorsal plate covering the hind part of the oblique metathorax, and small side plates are present in some cases, while the ventral plate is so short and small as to be easily overlooked. In the females the ventral and pleural plates are wanting upon segments nine and ten, the broad dorsal plate bending around the sides and approaching beneath to form the sheath for the ovipositor. In both sexes all the segments are similar except the last two or three, which in the females usually form a more or less sharp cone, while in the males, as a rule, the end is bluntly rounded; only a few species are formed alike in both sexes.

Spines.—Each segment bears, as a rule, but few spines, which are small upon the anterior segments, but increase in size and prominence posteriorly. These are most prominent upon the sides of the segments and especially around the last two, where they are called anal spines and are frequently very long and stout. In some species, as Quaintance has observed (454), these stout anal spines are the weapons of offense and defense.

Tubulifera.—In this suborder all but the first and the last one or two segments are formed alike. Each is composed of only a dorsal and a ventral plate joining at the sides by an indistinct suture. The ventral plate of the first segment is only slightly, if at all, developed, while the terminal segment appears to be a simple cylinder or tube and is formed alike in both sexes. The dorsal plate of the first segment, in some species, is drawn out anteriorly into a rounded projection, attaching to the metathorax, and on each side of the projection is a separate side plate. The arrangement and relative development of the lateral spines is much the same as in the Terebrantia. As a rule, upon the dorsal plates of segments two to seven inclusive, on each side at about one-fourth the cross diameter of the segment from the edge, there stands a pair of peculiar, inwardly bent, acute spines, and outside of these there is frequently a segmental row of much longer, straight, blunt spines. These dorsal spines appear to serve entirely for the confinement of the wings when at rest. The last segment bears at its tip a circlet of long, slender hairs, usually as long as, or longer than, the segment itself.

Stigmata.—Either three or four pairs of stigmata are present in Thysanoptera. In the adult they appear constantly at the anterior angles of the mesothorax, and on the sides of the first and eighth abdominal segments, while the fourth pair, always present in Tubulifera and sometimes distinguishable in Terebrantia as well, occurs close behind the attachment of the hind wings. Uzel states that four pairs of spiracles are present in the Terebrantia. This is surely often the case, but the metathoracic pair is very small, and in some species I can not find it even in specially prepared mounts, and in some cases where traces of the stigma can be found, I am convinced that it is vestigial and really functionless. The mesothoracic stigma is frequently elongated dorso-ventrally, sometimes being very narrow.

In the larvæ the stigmata are situated at the front angles of the mesothorax and upon the sides of the second (instead of the first) and eighth abdominal segments.

The structure of a stigma is peculiar. In a surface view at the sharpest focus, upon an anterior abdominal stigma of, e. g., *Anaphothrips striatus*, cleared in caustic potash, the stigma appears to be made up of a number of irregularly polygonal, cell-like bodies, separated from each other by dark lines and each cell showing one or more dark spots near its center. In focusing down onto its surface, its appearance changes quite strikingly. As it first comes into view, though before it is clearly seen, it appears as a dark field with quite regular, small, light spots, the dark lines giving a reticulate appearance. When a little more nearly in focus, the cells appear dark, while the central spots and the intercellular lines and angles are very much lighter. Brought into sharp focus, the cells are seen to be more irregular than they appeared at first, the surface appears light colored, whereas formerly it appeared dark, while the intercellular lines and central spots have now become dark (Plate X, fig. 112.) This reversal of the light and dark parts is peculiar and very noticeable. On one side of the center a larger, rather indistinct, rounded area can usually be seen, which is the bulbous enlargement at the end of the trachea opening by a quite large orifice to the exterior. A cross view of a stigma (Plate X, fig. 113) shows a remarkable structure. The cellular areas are now found to be mushroom-like bodies with slender stalks, standing with their heads close together. These are quite strongly chitinized and dark. Whether the little air chambers between them connect in any way with the trachea has not yet been determined.

SEXUAL CHARACTERS: TEREBRANTIA.

Female ovipositor.—The most prominent external sexual character of the female is the ovipositor which is attached to the ventral side of the eighth and ninth abdominal segments (Plate XI, fig. 121) and is

plainly visible through the body of the insect. It is composed of four distinct plates or valves, two of which, forming the under or anterior pair, are attached to the very narrow ventral plate of the eighth segment and two, forming the upper or posterior pair, are attached to the sides of the ventrally extended dorsal plate of the ninth segment. The ovipositor as a whole is curved either upward (Æolothripidæ) or downward (Thripidæ) and terminates in a very slender, sharp point. The valves lie very closely together, but their inner surfaces are grooved, forming a passageway for the egg. The two plates on each side are fitted together in such a way as to slide back and forth upon each other without being displaced. The upper edge of the lower plate is grooved and into this groove fits a ridge or tongue formed by the lower edge of the upper plate. The upper edge of the upper plate, except at its base, is fitted with sharp, saw-like teeth pointing toward the base of the valve. The lower plate is provided with similar teeth on the under side of its distal third, while the middle third bears a number of peculiar, broad-cutting teeth. The ovipositor is movably connected with the abdomen by a number of small supporting plates or levers which also assist in its manipulation.

In at least two species of Thripidæ known to me, the ovipositor does not appear to be functional though it is plainly present (*Chirothrips obesus* and *Thrips perplexus*).

When not in use, the ovipositor is drawn up close to the body and is received into, and entirely enveloped by, a membranous sheath along the last two segments which is made possible by the absence of the ventral plates at this place. The sexual opening is between the eighth and ninth segments in all Terebrantian females.

As a rule the conical form of the tip of the abdomen also indicates a female. In many of the light colored species, just in front of the base of the ovipositor, is a plainly visible internal organ which has sometimes been called the seminal receptacle. It usually appears as a small spherical or rounded body of an orange or brownish color, agreeing closely in this respect with the color of the spermaries of the males in species where males are known. This organ presents the same appearance, however, in certainly unfertilized females of bisexual species, and it is also always present, having the same size and color in several species known to me in which the males are extremely rare or possibly wanting altogether. Certainly a seminal receptacle can not be functional in parthenogenetic species, yet I have found this organ constantly present through eight or ten generations of a species bred in the laboratory where males were never produced.

Male.—Males are, as a rule, considerably smaller than the females. The abdomen is usually bluntly rounded at the end instead of sharply conical, though a few species resemble the females in this respect. The stoutest spines are usually at the sides of the ninth segment. In

Æolothripidæ this segment is much larger than the others and is drawn out at its hind angles into hooks and processes which apparently assist in copulation. The sexual opening is between the ninth and tenth segments, and frequently from this point there protrudes more or less of the retracted copulatory apparatus, which is usually entirely drawn into the ninth segment through the walls of which it can be more or less distinctly seen. Three separate outer parts, which are strongly upcurved, can be seen proceeding from a complex basal part and the entire apparatus is protrusile. Within the abdomen the two elongated, irregularly pear-shaped, orange or brownish colored spermaries are plainly perceptible, lying usually in about the seventh and eighth segments. Upon the ventral surface of the second to the seventh abdominal segments, inclusive, in many species there are distinct rounded or transversely elliptical depressions found only in the males. Males are often lighter in color and quicker in movement than the females.

TUBULIFERA.

Female.—The sexual characters of Tubulifera are much less distinct and numerous than are those of the other suborder. The end of the abdomen is tubular and the sexual opening is between the ninth and tenth abdominal segments in both sexes. In this region are also found the strictly distinctive characters. In the female the basal edge of the tube is regular and entire. Near the hind edge of the ninth segment below there is a short, strongly chitinized rod (Plate X, fig. 115) which is dark and plainly visible in light colored species, but when the body at this point is nearly opaque, the rod can not be seen and the question of sex is often in doubt.

Male.—The male is usually smaller and more slender than the female, the sixth, seventh and eighth segments of the abdomen being noticeably narrower. The base of the tube is cut out below in the form of a semicircular notch (Plate X, fig. 114), which can usually be plainly seen except in very dark specimens, and through the opening formed by this notch the sexual apparatus can be protruded. The structure of this apparatus is much the same as in the Terebrantia and in light colored specimens it can be seen wholly retracted within the ninth segment. In some species this segment bears a broad scale at the base of the tube. In a few species the sixth segment bears on each side a thick, fleshy, unjointed appendage. The males in many species have more strongly thickened fore femora and stouter teeth upon the fore tarsi than do the females.

Copulation.—This I have rarely observed, and therefore the following statements are mainly gathered from Jordan's article (306).

In the Tubulifera the male rests upon the back of the female, and holding firmly to her thorax by his legs, he places the ventral surface of his abdomen along the side of the abdomen of the female and bends

the extremity under the abdomen of the female, so that the ventral surfaces of the last segments are toward each other. The copulatory apparatus of the male is then pushed out, while the female bends the tube upward so as to leave the sexual opening free. Copulation lasts for about half a minute, when the female begins to move and the male leaves her back, but the connection is not at once broken, and the stronger female drags the attached, struggling male behind her for some distance. One male fertilizes a number of females successively. In one case Jordan states that a male of *Phlæothrips brunnea* Jordan, in one-fourth of an hour, fertilized six females, and his spermaries were still about half filled.

In the Terebrantia the males are carried around upon the backs of the females and the union takes place in much the same manner as has just been described for the Tubulifera.

DEFORMITIES.

Slight deformities are by no means rare. The most common form consists in a reduction in the number of segments in one or both antennæ, brought about, in most cases, by the fusion of two or more segments at the end, though intermediate segments are sometimes wanting. It frequently happens that the antenna with fused segments is scarcely shorter than the normal one. Only very rarely does it appear that a reduction in number is the result of injury, though this would seem very possible. So far as is known, an increase over the normal number by a division of segments never takes place. Sometimes the wings are so deformed as to be useless. Deformities in the abdomen are very rare, but I have found two cases. One in which the posterior segments were constricted being abruptly smaller than the preceding, the other with a half segment wanting on the left side at about the middle of the abdomen. The right half of the segment was wedge-shaped, reaching in to the median dorsal line and giving the abdomen a corresponding crook at that point.

REPRODUCTION.

The method of reproduction in this group is of interest and also has an important bearing upon its distribution. So far as known, it is always oviparous and sexual, but two distinct forms are common in most species.

Bisexual reproduction.—This is the normal and most common form, but the two sexes are not found in anything like equal proportions, as females are almost always more abundant than males. This may be the case and reproduction yet be entirely bisexual, as in some species, perhaps in all, one male fertilizes a number of females. In a few species the males are found abundantly throughout the year; in others they are abundant only at certain seasons; in others males are rarely found at

any time; in still others, while the females are very abundant, males are unknown. The explanation for the relative scarcity or absence of males is found in the second method of generation.

Unisexual reproduction. Parthenogenesis is the usual mode of reproduction in at least ten species, all Terebrantia, and probably occurs very frequently in many others, though positive statements can not be made upon this point until more extensive collecting has been done and life histories have become better known.[a]

It seems that parthenogenesis must take place to some extent in those species in which the males are comparatively rare or are active for only a short season. However, no such thing as a regular alternation of generations, as in Aphidæ, is yet known to exist among Thysanoptera. In his studies of *Parthenothrips dracænæ* Jordan found that the normal method of reproduction in warm greenhouses was unisexual, while on plants standing in a cool room an abundance of males was developed, and this condition lasted in the cool room throughout the winter season. The males of *Aptinothrips rufus* have been found only at haying time, and then only very rarely.

DISSEMINATION.

It has already been noted that in most species there appear for some part of the season, in some generation or in one sex, individuals bearing fully developed wings, and we can not doubt that the wings play a large part in the distribution of the species. Certain it is that the power of flight is greater than would seem possible with such delicate wings as these insects possess. After harvest or toward autumn some species fly in large numbers, and in some instances have caused considerable annoyance by entering houses for hibernation. Winds may easily carry them for considerable distances, and when so scattered it is evident that their power of parthenogenetic reproduction is of great assistance in the establishment of the species in a new locality. Species living under the bark of trees growing upon the banks of streams are probably often carried for long distances on wood floating in the water, as some species which have been observed are found to endure a large degree of moisture and even submersion for some time without injury, and moist, decaying wood is their normal food. Species living upon cultivated plants, as in greenhouses, have doubtless been disseminated in commercial ways. Strange as it may seem, a species which is entirely wingless (*Aptinothrips rufus* (Gmelin) is one of the most widely distributed. It is hard to believe that this species can have attained its present distribution in both Europe and America through the slow method of crawling.

[a] Males of the following species included in this paper are rare or unknown: *Parthenothrips dracænæ, Heliothrips hæmorrhoidalis, Aptinothrips rufus, Anaphothrips striatus, Thrips tabaci.* Some others are too little known to be placed here.

Perhaps it may not be too much out of place here to speak more particularly of other movements aside from flying. The Tubulifera are very slow and deliberate in their movements, both in crawling and flying, and they never spring or run. Terebrantia vary in this respect, though in general they are much more active, and many run quite rapidly and take flight quickly. Some possess a power of springing which is well developed and often used in place of flight. The abdomen, head, and prothorax are raised and the little creature balances itself by its middle legs. Then suddenly the upraised parts are brought down together and the insect is thrown a considerable distance by the force of the contact.

DEVELOPMENT.

Oviposition.—As may be inferred from what has been said of the sexual apparatus of the two suborders, each has its own method of oviposition. The Terebrantian female cuts a slit with her saw through the epidermis and deposits her eggs singly in the tissue of the plant. The process of oviposition is as follows in *Anaphothrips striatus* and will doubtless hold in most points for the group:

The abdomen is raised somewhat and the ovipositor is let down from the sheath till it is nearly at right angles to the body. The abdomen is arched to bring the weight of the body to bear upon the slender saw, the valves of which are then moved back and forth upon each other by powerful muscles in the ninth segment. The toothed blades are gradually worked down somewhat obliquely into the tissue, and when the slit is sufficiently large there may be seen successive contractions of the abdomen as the egg is pushed out between the valves of the ovipositor and under the epidermis till it is nearly concealed. The entire operation requires about one and a half minutes, and upon its completion the female moves off a short distance to rest or feed. Occasionally the ovipositor becomes so firmly wedged in the plant as to hold its possessor prisoner for some time, frequently until death results (469).

I feel sure that *Thrips perplexus* and *Chirothrips obesus* will be found to deposit their eggs externally.

The number of eggs laid by a single female has been observed only in the case of *Anaphothrips striatus*, from a number of which an average of from 50 to 60 was obtained, the maximum average from a lot of 5 females being 72. These observations were made in the laboratory upon females confined in bottles. The percentage of eggs which hatched was also observed in this species and was found to vary in the laboratory from 35 to 40 per cent. It seems very probable that the artificial conditions under which these experiments were made must have in this case greatly reduced the percentage that hatched below the normal.

Tubulifera deposit their eggs externally, either singly or in groups, upon leaves and flowers or under bark, etc., according to their habitat. The period of oviposition in all species in this order is quite long.

Egg.—The eggs of Terebrantia are more or less elongated and slightly bean-shaped. They are colorless, delicate in structure, and no micropyle is apparent. The position of the eggs in a thin leaf is easily seen upon holding the leaf before a bright light, when they appear as brighter spots in the darker green tissue of the leaf. Eggs are laid in almost any green part of the plant, but not in the petals of flowers.

The eggs of Tubulifera are of an elongate-oval shape, attached with the long axis perpendicular to the surface, and have at the free end a thickening of the chorion with a micropyle in the middle. The eggs vary from yellow to brownish in color.

Embryology.—The development of the embryo can be observed in the translucent eggs of Terebrantia. Various writers agree in stating that the germ band is immersed. Before revolution the appendages of the embryo lie along the convex side of the egg, after revolution along the concave side. The length of the egg stage varies considerably in different species and, even within the same species, according to the weather conditions. So far as life histories are known, this stage appears to last from three to fifteen days in Terebrantia, but no record is found upon this point for the Tubulifera. The pigmented eyes of developing embryos are particularly prominent. If the egg bed dries the egg is quickly destroyed, but if moist, even though decaying, the development continues.

Emergence of the larva.—When ready to emerge, the young Terebrantian larva breaks through the tender chorion and pushes up through the slit in the epidermis made for the insertion of the egg. The larva works its way up till all but the tip of the abdomen is free, but remains supported by the tip in this upright position until the antennæ and legs have separated from the body, to which they are at first closely applied, and have become sufficiently dried and hardened for use. It then falls forward onto its feet and is ready to travel or to feed almost immediately. No observations have been found on this point for the Tubulifera, but just as their eggs are laid singly or in groups, so also do we find the larvæ.

Larval stage.—The length of the larval stage varies with the species, and the statements recorded place it at from five to forty days.

When just hatched the head of the larva is very large in proportion to the body and the mouth parts are essentially like those of the adult. The thoracic segments are subequal. The abdomen is strongly contracted and very rough. As the larva grows the thorax and abdomen enlarge noticeably, while the head shows little change. In some species (*Heliothrips*) the abdomen becomes strongly distended and shining as though under considerable pressure, and a globule of fluid excre-

ment is frequently held by the hairs around the anus. The larvæ are less active than the adults and have no power of springing. The larval antenna always has fewer segments than the adult. In Phlœothripidæ the number is constantly seven. Thickened femora and tarsal hooks do not occur, the tarsus appears to be one segmented, and claws may or may not be present. The structure of the foot is much more distinct than in the adult. The eyes are not compound, but composed of a few separated facets, which are strongly elevated and always circular in outline. The number of facets increases in successive molts, but the circular form is retained. The rudiments of the ovipositor or genital apparatus appear on the under side of the eighth and ninth segments as indistinct lobes. The food habits of the larvæ are just as varied as are those of the adults, and some species are also found upon the roots of plants.

Molts. From two to four molts appear to occur while in the larval stage, the last marking the change to the pupa. The chitinous covering of the internal mouth parts and of the bladders can be distinctly seen in the cast skin. When larvæ have become full grown they cease to feed, become restless, and seek some very secluded place in which to molt. In this search they are so successful that in many species pupæ are hard to find.

Nymph or Pupa. The metamorphosis of Thysanoptera is peculiar, for though complete in many respects, it is much less so in others. Two stages are distinguishable while in the nymph condition. After the last larval molt, the insect still retains its larval appearance, the antennæ are extended, and the pro-nymph is moderately active. The wing pads are partially developed, extending to about the second abdominal segment, and the beginning of the formation of the adult appendages can be seen. After another molt, the true nymph stage is reached and the animal remains quiet unless disturbed, when it is capable of slight movement. No food is taken during this period. The antennæ are laid back upon the head and prothorax; their segmentation has become indistinct and the adult antenna can be seen within the nymphal skin. The number of facets in the eyes greatly increases, producing the adult condition. The legs are inclosed in loose sheaths and the wing pads reach to and from the sixth to the eighth segments. The pads extend obliquely outward along the sides of the body and do not cover each other. The fringes appear along the edges of the forming wings, the fore fringe being directed toward the tip and hind fringe toward the base of the wing. The forming lobes representing the ovipositor elongate, and those on each side overlap but remain separate. Within them develop the pointed valves of the adult ovipositor, which now extends to the tip of the abdomen. The development of the male genital apparatus takes place in a very similar way to that of the ovipositor of the female. The nymph stage

is passed in some secluded place, pupae being found in the loose soil about the base of the plant, in the leaf sheath, or some similarly protected place, and many have been recorded as transforming in galls. When these changes have been completed, another molt takes place and the adult emerges.

The most noteworthy points in the metamorphosis may be summarized as follows: The larva resembles the adult in general form and in mouth parts; wings are developed in external sheaths; the transitional stage between larva and adult is quiet, and during it no nourishment is taken. The metamorphosis is therefore intermediate between complete and incomplete.

Hibernation.—Thysanoptera pass the winter in either larval, pupal, or adult stages. Many species, without doubt, hibernate in very nearly the same places in which they have fed. The bark-inhabiting forms remain in such places, together with many of the leaf forms which migrate onto the trunk. The dried stems of flowers and grasses shelter many species, while many of the leaf-inhabiting forms fall to the ground and are among those which may be found under fallen foliage, in moss, etc. Lichens and fungi shelter some as winter guests, while dead grass and turf contain many forms. It appears very probable that some of the larvae which have been found upon the roots of plants were hibernating there rather than feeding thereon, as has been supposed.

The hibernating individuals appear to be able to withstand extreme degrees of cold and moisture. I have brought in a number of species gathered by pulling the frozen grass from bare mowings in midwinter after a temperature of −21° F. Upon being brought into a warm room, they very soon became active and ran about.

Thrips emerge from hibernation very early in the spring, and as soon as their normal food plants begin to grow most of them are in a condition to deposit eggs for a new generation, which in some cases in Massachusetts hatch during the latter part of April or the first of May.

Length of life.—Few observations have been recorded upon this point, but it seems improbable that even the longest lived exceed a single year. Among those species which produce several generations in a season, the hibernating individuals must live for at least seven months in the northern United States while the summer generations are much shorter lived. Their age however, as a rule, considerably exceeds the length of the life cycle, for oviposition is a slow process, and in *Anaphothrips striatus* is known to extend over a period of five or six weeks. As a result of this there is an indistinguishable overlapping of broods. I have kept a female of a midsummer generation of *A. striatus* confined in a bottle in the laboratory for almost five weeks. This species has eight or nine generations in a season, and may therefore be expected to be one of the shortest lived in summer.

ECONOMIC CONSIDERATIONS.

INJURIOUS FORMS.

Small and apparently insignificant though these insects are, they can not be disregarded from an economic standpoint. Only a few species, to be sure, must be considered as decidedly injurious, but these are widely spread and hard to control. Doubtless much damage, really caused by these tiny foes, has been attributed to more conspicuous but less injurious insects. The most important species in this country belong to the family Thripidæ. The economic importance of each of these species is considered in connection with its description, but there are, however, some general points worthy of note which may be considered together here.

Feeding habits.—Thrips are found upon most flowering and some flowerless plants. The general mode of feeding is the same throughout the order. The green parts of the plant, chiefly, are punctured by the piercing mouth parts and the sap withdrawn therefrom by suction. The emptied plant cells become white and shriveled as they dry up and the insect, standing usually parallel to the veins of the leaf, moves on to fresh cells. The traces of their feeding are thus left in irregular streaks of dried, whitened cells. Behind them, as they feed, they leave rows of dots of dark colored excrement, which, it seems, have sometimes been mistaken for eggs.

On flowers Thrips are most abundant in summer. Burmeister states that the nectar of flowers furnishes them with nourishment, and Pergande has expressed a similar opinion (219); but this does not seem to me to be the case, as when present on flowers they are found sucking sap, not nectar. They feed to some extent upon the petals, but not so freely as upon the green parts. The inner surface of the sepals is a favorite place for feeding and oviposition. The essential parts of the flower come in for their part of the general attack and it is just here that the greatest injury to the plant is caused. Injury of this sort has been reported, especially upon strawberries by Quaintance (454), and upon apple and other fruit blossoms by Osborn (218, 223, 224), in which cases they caused so much injury to the styles by their punctures as to prevent fertilization and the setting of the fruit. (See *Euthrips tritici*, p. 152.) Probably *Euthrips tritici* and *Thrips tabaci* are guilty of most of such injuries. Mally has recorded a very similar injury to cotton bolls by an undetermined species of the family Thripidæ (341). Many other flowers, though perhaps of less economic importance, are similarly attacked. Flower species feed also upon leaves.

On the leaves of plants and trees may be found a large variety of species, most of which feed mainly upon the under surface of the leaves, probably chiefly for protection from sun, rain, and enemies.

though it is also possible that more tender tissues may be an attraction. Such species avoid the light and, if a leaf be turned over, the insects will move around to the under side again. The constant sucking of myriads of larvæ and adults soon causes the feeding ground to wither, the leaf becomes encrusted with dead cells and dark colored spots of excrement and it is not long before its death results. Unless disturbed, most species do not travel much, and thus in time there appears to be something of a colony feeding around the place where the mother has fed and deposited her eggs. Though many plants thus suffer from the destruction of their leaves, the onion seems to be most severely afflicted. (See *Thrips tabaci*, p. 183.)

Grasses and cereals may be included in a third class in which the nature of the injury is somewhat different. Besides the abstraction of sap from the leaves of these plants, Thrips cause a greater injury by attacking the tender axial stems, thus cutting off directly the supply of sap to the head, which therefore fails to bear fruit and may be entirely killed. This is the way in which "Silver Top" is caused, and it is impossible to estimate with any degree of accuracy the damage which results to the hay crop. Besides working in this way, Thrips are charged with attacking directly the growing kernels of cereals. In the case of wheat, rye, oats, etc., they suck the nutritious milk directly from the growing kernels in the ear and produce an abortive condition of much, if not all, of the head, which is then called "pungled."

Greenhouse species appear to be becoming more numerous and more injurious each year. The principal injury here is done to the leaves, and nearly all kinds of greenhouse plants are subject to attack. *Thrips tabaci*, which has recently come into prominence, especially in cucumber and carnation houses, has an unusually wide range of food plants. It has already proved to be a serious pest, capable of the complete destruction of a crop, and is exceedingly difficult to control.

BENEFICIAL FORMS.

Predaceous Thrips.—The late B. D. Walsh once expressed the opinion that Thrips "are generally, if not universally, insectivorous, and that those that occur on the ears of the wheat, both in the United States and in Europe, are preying there upon the eggs or larvæ of the Wheat Midge (*Diplosis tritici*), and are consequently not the foes, as has been generally imagined, but the friends, of the farmer" (127 and 132). Such an opinion from so eminent an entomologist is likely to have some basis in fact, though we question whether his conclusion is even usually correct. Thrips have been frequently found in the galls caused by other insects, either with the makers of the galls or alone, and the conclusion has been drawn, though frequently, we suspect, without a direct observation to that effect, that the Thrips were preying upon the makers of the galls. Walsh also writes that he has

"found Thrips preying upon the gall-making larvæ of more than twenty different galls, so that there is now no manner of doubt in my mind that Thrips is a true cannibal insect" (132). All recorded observations which I have seen seem to agree that such gall-frequenting forms belong to the Phlœothripidæ, and in very many of the cases noted it is said that they are in the pupal stage (123).

It seems to me entirely possible that in many cases their presence in the gall may be incidental, they having entered it for protection. It is impossible for Thrips to make for themselves an entrance into any closed gall, and when present in such it can only be after the exit of the gall maker or some parasite upon it, so here certainly the Thrips is not predaceous. Furthermore, it does not seem improbable from what we know of the food habits of the Tubulifera, which feed mainly upon leaves or decaying wood or fungi, that they may live peacefully in company with the true maker of an open gall which they can readily enter, finding there the same favorable conditions for abundant food and a secure retreat as does the gall maker. Phylloxera galls have often been found to contain Thrips, but the same doubt exists as to the real purpose of their being there. Walsh states that he has found six or seven red Thrips pupæ in nearly every gall of *Phylloxera caryæ-foliæ*. This observation shows plainly one object for which these insects seek out and enter galls, as a safe refuge during pupation, and this will account for the frequent presence of larvæ and adults in both inhabited open galls, as those of Phylloxera, and deserted closed galls, as those of Cynipidæ. It may be true that Thrips prey upon the gall makers, but further observations upon this point are desirable before we can fully accept that conclusion.

"*Thrips phylloxeræ*" of Riley's manuscript (one of the Phlœothripidæ) is said by him to "do more than any other species to keep the leaf-inhabiting grape Phylloxera within bounds" (165). A species of *Phlœothrips* has been observed destroying eggs of the Gypsy Moth (353).

Some species of Thripidæ have been observed feeding upon other insects and are undoubtedly beneficial. *Thrips 6-maculatus* has been repeatedly observed feeding upon "mites" or "red spiders," and other species have been said to do the same. Riley observed a Thrips larva feeding upon the eggs of the Curculio in Missouri (143a and 144). *Thrips trifasciatus* Ashmead is apparently predaceous and was observed feeding on the cotton Aleurodes (*Aleurodes gossypii*) in Mississippi (386). I have occasionally noticed that under the influence of confinement without plant food *Anaphothrips striatus*, which is certainly normally herbivorous, becomes cannibalistic and will feed upon its own species.

Flower fertilizers.—It is very probable that a few flowers, of which the "wild pansy" is one, are fertilized by Thrips, although such a relation must be exceptional. Few flowers are adapted to thus profit

by the presence of Thrips, as their action would tend almost entirely to self-fertilization of the flowers, which Nature does not generally approve. Therefore I believe that their value in this way must be very limited.

NATURAL CHECKS.

Insects and Acari, etc.—The most important insect enemy appears to be *Triphleps insidiosus* Say, which is very common on flowers and may often be found with a Thrips impaled upon its rostrum and held in the air while the captor sucks the juices from the body of its victim. The eggs of *Triphleps* are laid in a similar manner to those of Thrips and the larvæ of the former also prey upon the larvæ of the latter. The length of the life cycle of *Triphleps* is about the same as that of Thrips. *Megilla maculata* also devours Thrips in great numbers when both are abundant. *Chrysopa* and *Syrphus* larvæ have been found feeding upon the larvæ of *Thrips tabaci*. Heeger has recorded *Scymnus ater*, *Gyrophaena manca*, and some fly larvæ as preying upon them, and Uzel has found *Triphleps minuta* also.

I have frequently found *Anaphothrips striatus* bearing one or more small, scarlet Acari (probably the larvæ of a *Trombidium*) attached to some membranous area of the body.

Both Uzel and Quaintance have found the eggs and adults of Nematode worms in the bodies of Thrips, Uzel recording over 200 worms from one specimen.

Plant parasites.—Thaxter (297) has taken *Empusa* (*Entomophthora*) *sphaerosperma* Fries from a species of Thrips which it was destroying in larval, pupal, and adult stages. Pettit has found in Michigan another parasite which he thinks will prove to be a Gregarinid (464). It was most abundant in the moist breeding cages, causing the insects to die and turn black. I have rarely found a fungus growing in a dead specimen which appears to be a species of *Macrosporium*, but it was not possible to tell whether the fungus caused the death of the insect or came in later.

Rain.—Of all the natural checks, none can compare in efficiency with a hard dashing rain. It has been noted that *Thrips tabaci* and *Anaphothrips striatus*, which become extremely abundant during hot, dry weather, disappear almost entirely as soon as the heavy showers of midsummer begin, and as long as such showers continue at frequent intervals the Thrips do not again become abundant. The same result will probably be found true in most outdoor leaf-inhabiting species.

ARTIFICIAL CHECKS.

These fall naturally into two groups, insecticides and cultural methods.

Insecticides.—So far as we know, no attempts to control Thrips by means of insecticides have been made outside the United States. Here

each of the three most important economic species, *Thrips tabaci*, *Euthrips tritici*, and *Anaphothrips striatus*, has been experimented with considerably. Webster recommends, for *Thrips tabaci* in the field, spraying thoroughly with 1 pound of Standard whale-oil soap in 8 gallons of water (476), and he says also, "The grassy borders of ditches have been sprayed with kerosene with excellent results." Quaintance (454) tried many insecticides for *Thrips tabaci* and *Euthrips tritici* in Florida and found that "rose leaf insecticide" 1 pint in 8 gallons of water killed from 65 to 70 per cent of the insects, and was the most successful of anything tested. For *Thrips tabaci* he recommends "whale-oil soap (Anchor brand), at the rate of 1 pound of soap to 4 gallons of water," or "rose leaf insecticide at the rate of 1 pint to 4 gallons of water."

Sprays must be very thoroughly applied to do even fair service, and ditches and margins around fields, as well as the ground between rows, should be treated also. Even with the most careful treatment many of the tiny insects will escape the spray, and the embedded eggs are entirely unharmed. Therefore, spraying, to be at all successful, must be repeated after a short interval. It must be admitted that at best spraying is an unsatisfactory remedy; still, it is perhaps the best method we know of at present for field work.

In greenhouses spraying may be more successful than in the field, but fumigation methods are here preferable. These also must be repeated in about a week to be successful. The most satisfactory results have here been obtained by the vaporization at night of 20 cc. of "Nikoteen" in 750 cc. of water for 5,000 cubic feet of space. This treatment did not injure the cucumber plants, while nearly all of the *Thrips tabaci* were killed (471).

Cultural methods.—These are undoubtedly too important to be neglected, even if insecticides be used, and in some cases they may prove even more efficient than the latter. For the Onion Thrips, Webster says: "All culls, tops, and other refuse of onion fields should be burned in the fall." He also recommends the burning of the grass along ditches and around the margins of the fields in winter or early spring to destroy the hibernating insects (476).

For the Grass Thrips it seems that cultural methods are the only ones that can be of any considerable help. A thorough burning of the old grass in early spring before growth begins destroys large numbers of hibernating insects—Thrips and many others. The attacks of the Grass Thrips are worst upon old, worn-out meadows, fields, and lawns, largely because *Poa pratensis* (June grass) is most common in such places. Infested grass should be cut as early as possible or fed green. So far as I can learn, the seed of June grass is sold only in lawn mixtures and is not used for field seeding, though it comes in naturally as the other stouter-growing species which are usually sown run out. The appearance of a large amount of "Silver Top" is there-

fore a sign that the field is becoming exhausted. Such fields should be plowed, and it is advisable to plant with some cultivated crop for at least one season before re-seeding.

CHARACTERS OF THYSANOPTERA.

Small insects; length ranging from one-fiftieth to one-third of an inch. Wings usually present; four in number, long, narrow, membranous, never folded, with at most two longitudinal veins and few or no cross veins; hind margin always, front margin usually, fringed with long, slender hairs much exceeding in length the breadth of the membranous part of the wing; wings laid horizontally along the abdomen when at rest; wings sometimes reduced to short pads not reaching beyond the hind edge of the thorax and entirely absent in a few species.

Mouth parts intermediate in form between those of sucking and chewing insects, but probably used almost entirely for sucking; arranged in the form of a cone situated on under side of head and placed so far back that it lies almost entirely under the prothorax (see Plate X, fig. 111), and is more or less concealed from the side by the fore coxæ and femora. Mouth cone formed by the labrum, the broad, flat, triangular, external portion of the maxillæ bearing each a two or three segmented palpus, and the labium bearing two or four segmented palpi; these external parts grown together and not freely movable. Mouth always asymmetrical, only the left mandible being developed. Mandible and lobes of the maxillæ modified as internal, protrusile, bristle-like piercing organs.

Antennæ quite slender, six to nine segmented, situated closely together upon vertex of head. Ocelli always present when long wings are present, always absent in entirely wingless forms; usually present, sometimes absent, when wings are reduced to pads. Prothorax distinctly separated from mesothorax and freely movable. Meso and metathorax firmly and closely united; metanotum longer than mesonotum. Tarsi usually two but sometimes one segmented; the terminal segment fitted at the tip with a protrusile, bladder-like organ which can be withdrawn entirely within the segment so as to be invisible. Abdomen ten segmented. Terminal segment either conical or tubular. Three pairs of stigmata are always present and a fourth pair is found in all Tubulifera and many Terebrantia. In the adult these are situated one pair each upon mesothorax and first and eighth abdominal segments. The metathoracic pair in Terebrantia is small, invisible except in carefully prepared specimens, and in some cases I have been unable to find any trace of it. In the larva the stigmata are distributed in the same way except that they are present on the second abdominal segment and not on the first.

Young resemble adults in general form, structure of mouth parts, and in food habits. There is, however, a distinct pupal stage during

which the insect moves very little or not at all, and takes no food. The wings develop entirely during this stage and are outside the body skin. The metamorphosis approaches closely to a complete one, but on account of the similarity of larval and adult forms and mouth parts it must still be considered as incomplete. Reproduction is oviparous and frequently parthenogenetic.

METHOD OF MEASUREMENTS.

A few of the descriptions of Thysanoptera previously published have been found to be too brief and general for the recognition of the species. Another difficulty which has been noted in some descriptions is the giving of comparative dimensions relative to other species. This may be useful to the collector if he happens to have or know all the species referred to; otherwise he is at an utter loss to know what is meant. Having experienced these difficulties at various times, the writer came to the conclusion that each description should be absolutely complete in itself and independent of all others, and that therefore a system of measurements based entirely upon the species under consideration would frequently prove of service in the determination and separation of these insects. The eye can not be relied upon for exactness in this matter, as has been frequently found in the course of this work, and therefore all measurements given in the following descriptions have been made in the same way, by means of an eyepiece micrometer, as follows: A stage micrometer of reliable make was first proven to be accurate by comparison with a steel millimeter scale, then with each combination of lenses used the number of spaces on the image of the stage micrometer covered by the scale of the eyepiece micrometer were determined, two points being selected where the divisions coincided. Then the number of spaces covered on the stage micrometer was divided by the number of spaces of the eyepiece micrometer covering them, and the quotient was, evidently, the fraction of a micromillimeter upon the stage shown by one division of the eyepiece micrometer. This quotient may be called the factor of the eyepiece micrometer for that combination of lenses and will hold unchanged for any object measured with that magnification, but will of course vary for every other magnification. Illustration: Using a 1-inch objective and a 1-inch eyepiece (Bausch and Lomb) with the tube closed, I find that the fifty divisions of the eyepiece micrometer cover, say, exactly 1 millimeter of the stage micrometer. Dividing then 1 millimeter by 50, I have two one-hundredths millimeter, which is the factor for that combination of lenses. Now, placing the object to be measured upon the stage, we find, e. g., that forty-five spaces of our eyepiece micrometer just cover the object to be measured. Multiplying by the determined factor, we have two one-hundredths millimeter times forty-five, which equals ninety one-hundredths millimeter as the length of the object measured. This method has been used in

the determination of length and breadth of the species herein described.

When comparative lengths only are desired, as e. g. in the comparative lengths of segments of antennæ, relative length and breadth of the head, etc., there is no need to determine the actual measurement. It is sufficient to compare directly the number of spaces read upon the eyepiece micrometer, and this is the method used in such cases. In the case of the comparative lengths of segments of the antennæ, all measurements have been made with a ¼-inch objective and a 1-inch eyepiece. The measurements given show, therefore, not only a comparison between the segments of one antenna, but also between the segments of all antennæ so measured. The number of the segment has been given above the line, and directly below it the number of spaces of the eyepiece micrometer covering that segment. Illustration:

Number of segment,	1	2	3	4	5	etc.
Spaces of micrometer,	5	10	14	12	9	etc.

It has been found that there are slight individual variations in the lengths of corresponding segments in different specimens of the same species, and even in the two antennæ of the same specimen, still there is in general a quite close agreement in this respect and the proportions hold very well. The antennæ were selected for such critical study, because there is an evident variation in the proportional lengths of segments in each species, and because the antennæ are the most surely available for a careful, accurate study of any organs of the insect. Then, again, proportional measurements do not vary nearly as much as do the absolute measurements of different sized individuals.

All statements made as to lengths, both actual and comparative, in the descriptions herein given are based upon actual measurements made in one or the other of these ways, an average being taken of the total number of specimens used in the description.

In describing colors it has been my intention to follow a few definite rules, which are given herewith: First, to name colors in plain, well-known terms when possible; second, when the color being described appears to result from a mixture, in equal proportions, of two more elementary colors, they have been given together in the same form and connected by a hyphen (gray-brown); third, when a predominant ground color is modified by more or less mixture with another color, the name of the ground color has been given last with the modifying color preceding it (grayish brown). Depth of coloring is indicated by such words as light, dark, etc.

INDIVIDUAL VARIATIONS.

Individual variation must always be considered in specific determinations and due allowance made therefor. The most common variation will naturally be found in the line of color. It is probable that to a slight extent the age of the individual may influence the depth of the

coloring, because a short time is required, in several species which have been observed at least, after the emergence of the adult from the pupal stage before the full depth of coloring is acquired. There is, however, a common variation in color, apparently not due to difference in age, producing in some of the most variable species color varieties. These may be either lighter or darker than the color of the typical form, but, so far as our observations have gone, complete intergrades are to be found.

A variation from the usual number of segments in the antennæ is quite frequently met with, but this is always in the line of a reduction in number due usually to a fusion of the last two or more segments.

The length and breadth of the abdomen is, perhaps, the most variable character, as in most species the segments are slightly telescoped naturally, and being connected with each other by a flexible membrane are capable of great distension. This may be caused naturally by the simultaneous development of a number of eggs in the ovaries of a female. When specimens are mounted in balsam, glycerin, or any such medium for study, there is danger of compressing the body of the insect if care be not taken to have present plenty of the mounting medium, and the usual result of this compression is the distension of the abdomen.

Measurements of a series of specimens show that a variation, often amounting to one-sixth, sometimes as high as one-fourth, frequently occurs between the extremes in the size of individuals in the same species.

SYNOPSIS OF SUBORDERS AND FAMILIES.

1. Female with a saw-like ovipositor. Terminal segment of abdomen of female conical; that of males rarely like females, but usually bluntly rounded. Fore wings with at least one longitudinal vein reaching from base to tip of wing. TEREBRANTIA (p. 124). 2
   Female without an ovipositor. Terminal segment tubular in both sexes. Both pairs of wings similar in structure with only one median longitudinal vein, and this only partially developed, never reaching to tip of wing. . TUBULIFERA (p. 187). Includes single family Phlœothripidæ.

2. Antennæ with nine segments. Wings broad and rounded at the tips; fore wings with cross veins. Ovipositor of female up-curved ...... ÆOLOTHRIPIDÆ (p. 126).
   Antennæ with six to eight segments. Wings usually narrow and pointed at tips, without cross veins. Ovipositor of female down-curved . . THRIPIDÆ (p. 132).

CHARACTERS OF TEREBRANTIA.

Antennæ have from six to nine segments, the terminal segments being usually much smaller than the preceding. Ocelli absent in the entirely wingless forms (*Aptinothrips rufus*) as in all wingless Thysanoptera, and sometimes in the wingless males of species in which the females are winged, they are present in all long winged forms. Maxillary palpi usually three, sometimes two segmented, and labial palpi usually two, sometimes four segmented.

Prothorax rarely longer than broad, but usually transverse, frequently twice as wide as long, ordinarily rectangular in general outline and scarcely wider at the hind edge than at the fore edge, except in the genus *Chirothrips*, in which it is strongly broadened behind, where it is about twice as wide as at front edge. The fore wings are broader, stronger, and much more specialized than the hind wings, shaded darker, if shaded at all. As a rule they have more veins, there being usually two, sometimes apparently only one, fully developed longitudinal veins besides frequently a strongly developed vein following the border of the wing and known as the ring vein; cross veins are present in some cases. The veins are usually set with more or less numerous and conspicuous spines which vary in size, the smallest being minute and indistinct, the largest extremely stout and conspicuous, exceeding in length the breadth of the membrane of the wing. The membrane itself is thickly set with numerous microscopic spines. A fringe is always present upon the hind margin, consisting on the hind wing of one, on the fore wing of two rows of long usually wavy hairs. On the fore wing these rows appear to be placed at different angles to the edge, so that instead of the hairs being parallel when the wing is in action, they cross each other at a slight angle, thereby forming a meshwork which must add materially to the strength and resistant power of the wing. Spines such as are found on the other veins are wanting upon the hind margin. The fringe upon the front is always shorter than that upon the hind edge and is composed of a single row of stouter, more bristle-like hairs. The development of the fore fringe appears to be in inverse proportion to that of the spines borne upon the costal edge, and when these last are very stout the fringe is vestigial, though sometimes both fringe and spines are wanting on the costa. In many cases the shading of the fore wings takes the form of dark cross bands alternating with light or almost white bands or areas. The hind wings are more slender and more delicate than the fore wings and have but one median longitudinal vein, usually fully developed, and no ring or cross veins. The median vein is without spines such as are borne upon the veins of the fore wing. The hind fringe is single instead of double and the fore edge always bears a more or less well-developed fringe. Shading of the hind wings is very slight and a distinct banding of them is not known. When at rest the wings are laid straight back upon the abdomen, the fore wing of each side completely covering the hind wing and each pair lying parallel to but not upon the other. The hind fringes are very flexible or jointed at their attachment to the wings and when at rest point backward between them. The wings are very frequently reduced to small, rounded or oval pads which are usually invisible even when present. Rarely they are entirely absent, but when this is the case the structure of the thorax indicates the fact. The fore legs are often more thickened

than the others—in the genus *Chirothrips* they are extremely thickened. The hind legs are usually longest and sometimes exceed the abdomen in length.

The abdomen is constricted somewhat at its junction with the thorax and is always ten segmented. The terminal segments are usually shaped differently in the two sexes: in the females the last three segments form a cone the apex of which is quite pointed, and rarely the last segment is rather tubular instead of conical. The abdomen of the male is usually more slender and lighter than that of the female, and as a rule its end is much more blunt, though occasionally shaped much like that of the other sex. The ninth segment is comparatively large and contains the genital apparatus, and frequently the tenth segment is also much retracted within it. In the females the sexual opening is between the eighth and ninth abdominal segments, but in the males it is between the ninth and tenth.

The female has a four-valved, saw-like ovipositor fitted to the underside of the eighth and ninth segments and reaching to about the tip of the abdomen, sometimes a little beyond. When at rest this apparatus lies partially concealed in a sheath on the underside of the last three segments; when in action it can be let down so as to work at almost any angle less than 90 degrees. The copulatory apparatus of the male is almost or entirely withdrawn into the body, but it is freely protrusile.

The males are often quicker motioned and more active than the females. Most of the members of this suborder move rapidly, though some are quite sluggish; they run rapidly and take flight readily. Some species, provided with well-developed wings, seem loath to use them, and many possess a considerable power of leaping.

Family ÆOLOTHRIPIDÆ.

The antennæ are nine segmented. Ocelli are present in both sexes. The maxillary palpi are three segmented, and the labial palpi two or four segmented. The wings are large, broad, and rounded at the outer ends. In addition to a heavy ring vein, each fore wing has two longitudinal veins extending from its base to tip, where they unite with the ring vein on each side of the tip, while the hind wings have only a vestige of a median longitudinal vein. Four or five cross veins are present in each fore wing. The fore wings are without a fringe upon the front edge, though some more or less stout hairs are there present in some species. Both sexes bear a peculiar hook-like appendage on the underside of the second segment of each fore tarsus. (See Plate I, fig. 9.) The ovipositor of the female is bent upward so that its convex side is ventral. The males have the first abdominal segment much longer than the second. The members of this family run rapidly, having very long legs, but they do not appear to have the power of springing.

The genus *Æolothrips* is the only one of the three genera of this family found in the United States.

Genus ÆOLOTHRIPS Haliday.

Head about as broad as long. Ocelli present in both sexes. Antennæ nine segmented, the last three or four segments being very much shorter than the preceding and closely joined together; third segment much longer than any other. Maxillary palpi three segmented, geniculate. Prothorax about as long or a little longer than the head, without large bristles. Legs very long and slender; fore femora somewhat thickened in both sexes; hind femora broadened; fore tibiæ unarmed; second fore tarsal segment, in both sexes, with hook-like appendage. Wings usually present in both sexes; fore wing somewhat narrowed before the middle; fore part of the ring vein furnished with very short hairs, which hardly overreach the edge of the wing. Fore wings white, with two broad, dark cross bands. First abdominal segment in the males much longer than the second, and the ninth segment is drawn out at the hind angles into short clasping organs or hooks.

The two species which I place here can be distinguished by the presence of a white band around abdominal segments two and three in the female of *A. bicolor*, which band is wanting in the female of *A. fasciatus*. The last four segments of the antenna taken together are much longer in *A. bicolor* than the fifth, while in *A. fasciatus* the last four segments together are approximately as long as is the fifth alone.

ÆOLOTHRIPS FASCIATUS (Linnæus).

Plate I, figs. 1–3.

Thrips fasciata Linnæus, Syst. Naturæ, 10th ed., 1758, p. 457.

Thrips fasciata Linnæus, Fauna Svecica, 1761, p. 266.—Geoffroy, Histoire abrégée des Insectes, 1764, p. 385.

Thrips fasciata Linnæus, Syst. Naturæ, 12th ed., Holmiæ, and 13th ed., Vindobonæ, I, Pt. 2, 1767, p. 743.

Thrips fasciata Fabricius, Systema Entomologia, 1775, p. 745.

Thrips fasciata Schrank, Enumeratio Insectorum Austriæ indig., 1781, p. 297.

Thrips fasciata Fabricius, Species Insectorum, II, 1781, p. 397.

Thrips fasciata Fabricius, Mantissa Insectorum, II, 1781, p. 320.

Thrips fasciata Gmelin, Linn. Syst. Nat., 13th ed., Pt. 4, 1788, p. 2223.

Thrips fasciata Berkenhout, Synop. Nat. Hist. Gt. Br. and Ire., 1789, p. 123.

Thrips fasciata Fabricius, Entom. Systematica, IV, 1794, p. 229.

Thrips fasciata Stew, Elem. of Nat. Hist., II, 1802, p. 114.

Thrips fasciata Fabricius, Systema Rhyngotorum, 1803, p. 314.

Thrips fasciata Turton, A General Syst. of Nat. (Transl. from Gmelin's Syst. Nat., 13th ed.), II, 1806, p. 717.

Æolothrips (Coleothrips) fasciata Haliday, Ent. Mag., III, 1836, p. 451.

Æolothrips fasciata Burmeister, Handbuch d. Entom., II, 1838, p. 417.

Æolothrips fasciata Amyot and Serville, Hist. nat. d. Ins. Hemipt., 1843, p. 646.

Æolothrips (Coleothrips) fasciata HALIDAY, Walker, Homopt. Ins. of Brit. Mus., Pt. 4, 1852, p. 1117, pl. VII, figs. 31–42.

Æolothrips fasciata HEEGER, Sitzungsb. d. Acad. d. Wiss. Wien, VIII, 1852, pp. 135–136, pl. XXI.

Coleothrips trifasciata FITCH, Count. Gent., VI, Dec. 1855, p. 385.

Coleothrips trifasciata FITCH, Second Rept. Nox. Ins. N. Y. 1857, p. 308 (or 540).

Thrips fasciata DE MAN, Tijdschr. v. Entomol., 1871, p. 147.

Æolothrips (Coleothrips) fasciata, REUTER, Diagnoser öfver nya Thysanop. från Finl., 1879, p. 7, or Öfv. Fin. Soc., XXI, 1879, p. 214.

Coleothrips fasciata PERGANDE, Entomologist, April, 1882, p. 95.

Coleothrips trifasciata WEBSTER, Rept. Dept. Agr., 1886, p. 577.

Coleothrips trifasciata THAXTER, Rept. Conn. Agr. Exp. Sta. for 1889, (1889), p. 180.

Coleothrips 3-fasciata RILEY-HOWARD, Ins. Life, III, 1891, p. 301.

Coleothrips trifasciata TOWNSEND, Canad. Ent., XXIV, 1892, p. 197.

Coleothrips trifasciata GILLETTE, Bull. 24, Col. Agr. Exp. Sta., 1893, p. 15.

Coleothrips trifasciata DAVIS, Bull. 102, Mich. Agr. Exp. Sta., 1893, p. 39, fig. 10.

Coleothrips trifasciata COCKERELL, Bull. 15, N. Mex. Agr. Exp. Sta., 1895, p. 71.

Æolothrips fasciata UZEL, Monographie d. Ord. Thysanop., 1895, p. 72, pl. I, fig. 4; pl. V, figs. 46–48.

Coleothrips trifasciata DAVIS, Special Bull. No. 2, Mich. Agr. Exp. Sta., 1896, p. 13, fig. 4.

Æolothrips fasciata TÜMPEL, Die Geradflügler Mitteleuropas, 1901, p. 286, pl. XXIII.

Female.—Length, 1.63 mm. (1.36 to 1.76 mm.); width of mesothorax, 0.30 mm. (0.27 to 0.34 mm.). General collor yellowish brown to dark brown. Head slightly wider than long, rectangular in outline, retracted slightly within prothorax; cheeks arched but slightly behind eyes; front nearly straight; surface of head but faintly striated and bearing numerous minute spines. Eyes large, black, elongated downward; borders of eyes light; ocelli small, well separated, orange-yellow with maroon crescents. Mouth cone sharply pointed; maxillary palpi geniculate, three segmented; labial palpi four segmented; chitinous thickening extending from left eye connected with that at juncture of mouth cone with frons; just a trace of such thickening extends down from right eye; the two spines standing at base of frons close to transverse thickening are less than twice as long as subantennal pair of spines. Antennæ nine segmented, nearly three times as long as head and very slender, approximate at base; relative lengths of segments:

1	2	3	4	5	6 7 8 9
5.5	15	31	26	17	17

Segment one thickest, cylindrical; two is a little thicker than three; last five segments are closely joined and from base of six they taper gradually to the tip. Antennæ brown except tip of two and all but extreme tip of three nearly white; all segments quite thickly and uniformly clothed with short spines; those around tip of two being much the stoutest; no sense cones present, but both three and four

have an elongated, narrow, membranous sense area on under side of outer half; five bears a small, rounded spot of similar texture near tip below.

Prothorax somewhat wider than long, and a little wider than head, nearly rectangular in shape; sides but slightly arched, without conspicuous spines but with numerous minute ones. Mesothorax smoothly rounded at front angles. Metathorax slightly narrower at front end than mesothorax and tapering somewhat posteriorly. Wings always present, about one-seventh as broad as long, rounded at tips; fore wing heavily veined having a ring vein and two longitudinal veins which extend from the base and join the ring vein just before the tip of the wing; fore vein united to costa by two cross veins at one-third and two-thirds its length; longitudinal veins united by one cross vein just before the middle and the hind vein is joined to the hind ring vein opposite the outer front cross vein; hind wing veinless. No fringe upon costa of either wing, but costa and longitudinal veins set with a number of short, dark spines; hind fringe hairs short and straight, double row on fore wing. Fore wings with three white bands (at base, middle, and tip) and wider dark brown cross bands between these; hind wings with similar areas, but the two darker bands are so pale gray that they are hardly noticable. Legs gray-brown, dark brown in dark specimens, very long and slender; fore femora slightly thickened and tarsi armed with a peculiar, hook-like structure opposed to a stout tooth something like a forefinger and thumb (Plate I, fig. 9); first segment of all tarsi very short; all legs thickly set with short spines; all tibiæ armed with very stout spines at tips.

Abdomen about two-thirds the length of the whole body, small at base, enlarging to the middle; segments frequently overlapping considerably in the last half; last three segments long and tapering to tip; ovipositor very long and up-curved; spines upon last two segments long, dark, and conspicuous. Entire body yellowish brown to dark brown; connective tissue red.

Redescribed from seven specimens. No males found.

Food plants.—Alfalfa, buckwheat, celery, clover, Compositæ, oats, onion, tansy, wheat, various grasses and weeds.

Habitat.—England (Haliday), Vienna (Heeger), Finland (Reuter), Germany (Jordan, Bohls, near Berlin, Uzel), United States: Connecticut, Indiana, Iowa, Massachusetts, Michigan, New Mexico, New York, Ohio.

Larva.—"Larva yellow, the abdomen behind deeper orange, a whorl of hairs on each segment, more conspicuous on the last two; prothorax elongate; antennæ shorter than in the perfect insect, the number of joints similar; mouth nearly perpendicular, not inflected under the breast; joints of maxillary palpi not very unequal."—Haliday.

Life history unknown. Fitch observed that it was abundant on

wheat early in the season and afterward passed to later-flowering plants, such as tansy (*Tanacetum vulgare*). Webster found it common in all stages on buckwheat in Ohio.

Thaxter believed that this species caused the rust of oats in Connecticut. Davis has reported it as the most common species on the heads of clover in Michigan, and found it both in and out doors on many plants.

ÆOLOTHRIPS BICOLOR, new species.

Plate I, figs. 4–9.

Female. Length, 1.9 mm.; width of mesothorax, 0.29 mm.; width of abdomen, 0.38 mm. General color light yellowish brown to dark brown.

Head as wide as long, also as long and as wide as prothorax; cheeks slightly arched behind eyes; anterior margin slightly arcuate; occiput transversely striated, quite thickly clothed with minute spines. Eyes large, black, elongated downward, coarsely granulated, each facet distinct, slightly pilose; ocelli separated, bright reddish yellow, margined inwardly with maroon crescents. Mouth cone sharp; maxillary palpi three segmented, geniculate, third segment very small; labial palpi four segmented, first segment very short. Chitinous thickening around left eye connected with that uniting mouth cone to frons; only a short vestige of such thickening below right eye; two long, slender spines are borne upon frons in front of the middle of the transverse thickening and one equally long spine upon middle of labrum; these spines are many times as long as any others upon the head. Antennæ as long as head, pro and mesothorax together, slender, filamentous, approximate at base; relative lengths of segments as follows:

$$\frac{1}{8.1}\quad\frac{2}{13.2}\quad\frac{3}{37.1}\quad\frac{4}{2.9}\quad\frac{5}{19.6}\quad\frac{6}{12.6}\quad\frac{7}{7.3}\quad\frac{8}{3.8}\quad\frac{9}{2.9}$$

Segment one thickest, as long as wide; three to six slightly narrower than two; seven to nine tapering; the last very minute and conical. All segments, except three, of uniform brown color; three is very pale yellowish white, except brown band around apex; two is brown at base fading to light yellowish at apex. Segments three to nine quite evenly clothed with fine hairs of uniform size; three and four bear each a narrow, light-colored, membranous strip on outer part of underside, indistinct upon three on account of its light color; a small elliptical spot of similar structure near tip of five beneath.

Prothorax nearly square, slightly constricted in middle, with numerous minute spines, but none conspicuous. Mesonotum transversely striated; fore angles of mesothorax broadly rounded. Metanotum reticulate; metathorax tapering posteriorly. Wings broad, rounded at tips; fore wing with two longitudinal veins which bend outward

just before the tip and unite with the ring vein; fore longitudinal vein united to front part of ring vein by two cross veins at about the first and second thirds of its length and to the hind vein by one cross vein just before the middle of the wing; hind vein united to hind part of ring vein by one cross vein at about three-fifths the length of the wing. Fore part of ring vein and both longitudinal veins set with numerous short, dark spines; both pairs of wings thickly covered with microscopic spines; no fringe upon front edge of fore wings, but a very light one upon hind wings; posterior fringe on fore wings double, on hind wings single; hind wings veinless. Wings clear white; fore pair conspicuously marked with two broad, brown bands so that there are narrow white bands across the base, middle, and tip of the wing; hind wings almost clear white. Legs concolorous with body, very long and slender; fore femora slightly thickened, but less than half as wide as long; second segment of fore tarsus fitted with a peculiar hook-like structure recurved toward base of segment and at tip opposed to a stout tooth. All legs quite thickly set with small spines; hind legs much the longest, nearly as long as wings; each tibia armed at apex with two or more stout spines.

Abdomen small at base, enlarging gradually to its sixth segment, where it is about one-fifth as wide as the body is long; eight, nine, and ten tapering uniformly and quite abruptly; no marked difference in length of segments. Posterior part of segment one and segments two and three white or yellowish in color; remainder of abdomen yellowish brown to dark brown. No spines apparent upon the abdomen, except on last three segments; nine bears a circlet of eight long slender bristles near its posterior edge; ten bears six similar bristles. Ovipositor very powerful, up-curved, and extending a little beyond the tip of abdomen.

Described from nine females.

Cotype.—Cat. No. 6323, U.S.N.M.

Male.—Length but little more than 1 mm.; width of mesothorax slightly less than one-fourth body length. General color tawny yellowish with brown extremities to appendages, not nearly as dark as female.

Head subequal in length and breadth and slightly smaller than prothorax; spines in front of transverse thickening at base of mouth cone not conspicuously long. Antennæ three and one-half times as long as head, almost equal to length of abdomen; relative lengths of segments as follows:

$$\frac{1}{7.7}\quad\frac{2}{11}\quad\frac{3}{34.3}\quad\frac{4}{28}\quad\frac{5}{22.3}\quad\frac{6}{17}\quad\frac{7}{11}\quad\frac{8}{2}\quad\frac{9}{2}$$

Outer two-thirds of antenna dark brown; first three segments light gray-brown, two and basal half of three being lightest; antennæ very

hairy. Hind legs very slender, longer than abdomen; all femora and fore tibiæ brownish yellow shaded darkest above; middle and hind tibiæ and tarsi gray-brown to dark brown.

Abdomen very small, but slightly longer than antennæ and not as broad as mesothorax, narrowed somewhat at attachment to thorax, increasing gradually in breadth up to ninth segment; tenth segment very abruptly smaller and conical. Segment one very long and marked by two brown, longitudinal carinæ dividing it into thirds dorsally. Ninth segment also peculiar, being very long and as broad as any in the abdomen; hind angles produced into a pair of claspers, also bearing a pair of stout spines; tenth segment small and set with quite long, stout spines. Second, third, and fourth segments nearly white, sometimes irregularly suffused with yellow; rest of abdomen tawny yellow.

Described from three males.

Cotype.—Cat. No. 6323, U.S.N.M.

These males differ much more than is usual from the description of the female but it seems that they are more closely allied structurally to *A. bicolor* than to *A. fasciatus*, and so I place them with the former species.

Food plants.—*Brunella vulgaris*, *Panicum sanguinale*, bindweed, and various grasses in mowings.

Habitat.—Amherst, Massachusetts.

Family THRIPIDÆ.

The members of this family have from six to eight segmented antennæ (apparently nine segmented in *Anaphothrips striatus* and *Pseudothrips inequalis*); the segments beyond the sixth are usually short and form what is called the style. Maxillary palpi are usually three, sometimes two segmented; labial palpi never composed of more than two segments. The wings of Thripidæ are usually slender, gradually tapering more or less and pointed at the tips. The fore wings, as a rule, present two parallel longitudinal veins, the front one running from the base to near the tip of the wing; the hind vein appears usually as a branch from the fore vein at about one-third the length of the wing. Sometimes, however, all connection between these veins is wanting. Cross veins are rarely visible, though traces of them can sometimes be seen. The ring vein is not usually very heavy or prominent. A fringe is generally present upon the front margin of the fore wing, but may be vestigial. More or less stout spines are found along the veins and costa of the fore wing. The hind wing has one median, longitudinal vein without spines and no cross or ring veins, but the costa bears a fringe. The ovipositor of the female is bent downward, i. e., concave side ventral.

SYNOPSIS OF THRIPIDÆ.

1	Antennæ with eight segments	2
	Antennæ with seven segment	11
2	Body with markedly reticulated surface	*Heliothrips* (p. 168)
	Body without reticulate surface	3
3	Abdomen clothed with fine hairs and having a silky luster	*Sericothrips* (p. 141)
	Body without clothing of fine hairs	4
4	Last two segments of the antenna longer than the sixth	*Raphidothrips* (p. 158)
	Last two segments shorter than sixth	5
5	Terminal segment of abdomen with a pair of extremely stout, short spines near the tip above	*Limothrips* (p. 138)
	Terminal segment without unusually stout spines	6
6	Antennæ with second segment drawn out into an acute process on outer angle	*Chirothrips* (p. 133)
	Second segment of antennæ normally symmetrical	7
7	Ocelli and wings wanting	*Aptinothrips* (p. 166)
	Ocelli and wings present	8
8	With spines at hind angles of prothorax	9
	Without spines at hind angles of prothorax	*Anaphothrips* (p. 160)
9	With two long spines at each hind angle of prothorax	10
	With one long spine at each hind angle of prothorax	*Pseudothrips* (p. 146)
10	Without a long spine at middle of each side of prothorax	*Euthrips* (p. 147)
	With a long spine at middle of each side of prothorax	*Scolothrips* (p. 157)
11	Fore wings broad and without front fringe	*Parthenothrips* (p. 175)
	Fore wings slender, spines on outer half fewer than on basal	*Thrips* (p. 178)

Genus CHIROTHRIPS Haliday.

Body thickened. Head very small and in front of the eyes drawn out into a three-cornered process upon which the antennæ are situated. Ocelli present in the females and located very far back; wanting in the males. Antennæ eight segmented, the second segment ending in a blunt prominence at the outer angle. Maxillary palpi three segmented. Prothorax nearly twice as long as the head, and trapezoidal in form, being about twice as broad at the hind edge as at the fore edge. Two prominent spines present at the hind angles or wanting in some species. Legs short; the fore pair extremely thickened, so that the tibiæ are short and broad and the tarsi small. Wings long and very slender; fore wing with two veins upon which there stand a few small spines; front fringe well developed. Males wingless.

SYNOPSIS OF SPECIES.

1	With two moderately long spines at each hind angle	*manicatus* (p. 134)
	Without long spines at the hind angles	2
2	Abdomen light yellow	*obesus* (p. 137)
	Abdomen light brown	*crassus* (p. 136)

CHIROTHRIPS MANICATUS Haliday.

Plate II, figs. 14–16.

Thrips (Chirothrips) manicata HALIDAY, Entom. Mag., III, 1836, p. 444.
Thrips manicata BURMEISTER, Handb. d. Entomologie, II, 1838, p. 413.
Thrips longipennis BURMEISTER, Handb. d. Entomologie, II, 1838, p. 413.
Chirothrips manicata AMYOT and SERVILLE, Ins. Hemipteres, 1843, p. 642.
Chirothrips longipennis AMYOT and SERVILLE, Ins. Hemipteres, 1843, p. 642.
Thrips (Chirothrips) manicata HALIDAY, Walker, Homopt. Ins. Brit. Mus., 1852, p. 1106, pl. VI, fig. 12.
Thrips (Chirothrips) manicata REUTER, Diagn. öfv. nya Thysanopt. f. Finland, (1878–79), pp. 5, 6.
Chirothrips antennatus OSBORN, Canad. Ent., XV, 1883, p. 154.
Chirothrips antennatus LINDEMAN, Bull. d. Soc. Imp. d. Nat. d. Moscow, LXII, 1886, No. 4, pp. 322–325, fig. 12.
Chirothrips manicata JABLONOWSKI, Termes. Fuzetek, XVII, 1894, p. 47.
Chirothrips manicata UZEL, Mon. d. Ord. Thysanoptera, 1895, p. 80, pl. I, fig. 2; pl. VI, fig. 49.
Chirothrips manicata TÜMPEL, Die Geradfügler Mitteleuropas, 1901, p. 287.

Female.—Length 1 mm. (0.84 to 1.18 mm.); width of mesothorax 0.27 mm. (0.24 to 0.32 mm.). General color quite uniform dark yellowish brown.

Head somewhat shorter than wide, almost conoid in shape, frequently hidden up to the eyes in the prothorax; cheeks only about one-third the length of the eye; head prolonged into a triangular process in front of the eyes; a row of four small spines across the head between the front edges of the eyes and one small spine on each side of the anterior ocellus. Eyes large, black, rather coarsely faceted; ocelli subapproximate, almost white or pale yellowish with heavy maroon crescentic inner margins, placed in a low triangle far back between hind half of eyes. Mouth cone short, broad and blunt; maxillary palpi three segmented. Antennæ less than twice the length of head; segments thick and more or less rounded; relative lengths of segments as follows:

$$\frac{1}{5.8}\quad\frac{2}{5.9}\quad\frac{3}{6.4}\quad\frac{4}{7.5}\quad\frac{5}{6}\quad\frac{6}{8}\quad\frac{7}{2.5}\quad\frac{8}{2.5}$$

Basal segments very broad and almost contiguous; two drawn out into a short, blunt angle on outer side; three and four bear each one very stout, blunt sense cone on outer angle. All segments brown; tips of two and three frequently yellowish.

Prothorax large, trapezoidal, a little less than twice as long as head, as wide as head in front and twice as wide behind; sides nearly straight; surface dotted with numerous very small spines and marked with transverse, arched wrinkles, giving it a scaly appearance; numerous small spines stand at hind edge, and two spines at each hind angle are much larger than the others. Mesothorax a little broader than

the prothorax, widest behind, sides curving forward; metathorax abruptly somewhat narrower, and its sides curve inward to base of abdomen. Wings nearly always fully developed in females, about four-fifths as long as body and in middle about one-seventeenth as broad as long, sharply pointed at ends, heavily fringed on both edges. Hind longitudinal vein branches from the fore at about one-fourth the length of the wing; fore vein bears six or seven spines before the branching off of the hind vein; beyond this the fore vein bears usually two and the hind vein four spines; costa bears numerous short spines. Fore wings gray-brown; hind wings gray. Legs short and powerful; fore femora extremely short, nearly as broad at base as long, wrinkled on surface and at tip outside with chitin turned up into a sort of tooth; fore tibiæ also extremely short and thick; each tibia bearing a row of spines of gradually increasing length and stoutness on inner side toward tip; these are most strongly developed on hind legs. Legs dark brown except tarsi more or less gray or yellowish.

Abdomen broader than mesothorax, hardly twice as long as broad (segments usually overlapping considerably and giving a dark and light brown banded appearance); spines around last two segments moderately long and stout, dark brown and conspicuous; ovipositor of good length. Color of abdomen uniform dark brown; receptaculum seminis inconspicuous or invisible.

Redescribed from ten females.

Male. Length 0.83 mm. (0.66 to 0.96 mm.); width of mesothorax 0.22 mm. (0.20 to 0.24 mm.).

Ocelli wanting; spines on head as in female. Relative lengths of antennal segments as follows:

1	2	3	4	5	6	7	8
5.2	5.2	5.9	6.5	4.4	5.6	1.8	1.8

Segments two and three pale yellowish. Wings entirely wanting. Abdomen more narrow than in female and bluntly rounded at the end. Ninth segment very large, conoid; tenth segment retracted therein; ninth with a short stout spine on each side of the hind edge above; genital apparatus protruding beyond the tip of tenth segment; a rounded light depression in middle of ventral plates on segments three to six.

Described from five males.

Food plants.—Flowers of various grasses and cereals, clover, wild carrot.

Habitat.—England (Haliday), Germany (Burmeister, Jordan, Bohls), Finland (Reuter), Russia (Lindeman), Bohemia (Uzel), United States: Manchester, Iowa; Amherst, Massachusetts.

Life history unknown except that they hibernate in dried flower stems and in turf.

I have compared my specimens with those of Osborn's *C. antennatus* and they are identical.

CHIROTHRIPS CRASSUS, new species.

Plate II, figs. 17–20.

Female.—Length 0.78 mm.; width of mesothorax 0.26 mm. General color of head and thorax brown; abdomen gray-brown or yellowish brown.

Head very small, slightly wider than long, narrowed in front between the eyes and elongated anteriorily; distance between eyes equal to one half the width of head; frons between antennæ bluntly acuminate. Eyes reddish orange by reflected light; ocelli placed in a low triangle far back between hind edge of eyes; each ocellus pale, margined inwardly with a dark-red crescent. Mouth cone very short and broadly rounded; maxillary palpi short, three segmented. Antennæ approximate at base; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
4.5	6	7	6.5	6	8.3	2.8	3

Basal segments large, longitudinally compressed, nearly twice as wide as long; segment two drawn out at outer angle into an acute process; three with slender peduncle, subpyriform, bearing one prominent sense cone on outside, as does also four; four and five rounded; four nearly as thick as long; five somewhat narrower; six elongated; seven and eight moderately slender. One and two pale straw yellow; three to six shading gradually to a medium brown; seven and eight also medium brown.

Prothorax one and one-half times as long as head, one and three-fourths times as wide as long, twice as wide at posterior edge as at anterior; sides nearly straight, indented above fore coxæ, with prominent spines at posterior angles. Mesothorax one and one-fourth times as wide as prothorax, quite a deep constriction between mesothorax and metathorax; pterothorax with more or less rusty tinge. Wings long, saber-formed, slightly overreaching the tip of the abdomen; fore wings shaded with gray, hind wings nearly clear. Fore longitudinal vein extends through the wing; hind vein arises from fore vein at one-third its length; both veins disappear before reaching the tip of the wing. Fore vein bears two spines on distal half; hind vein bears five spines. Legs short; fore pair strongly thickened; all femora grayish or yellowish brown; fore tibiæ and all tarsi pale yellowish; middle and hind tibiæ brownish at bases and above, fading to pale gray or yellow beneath and at extremities.

Abdomen elongate-ovate in outline, bluntly pointed at tip, one and four-fifths times as long as broad; spines upon last two segments short, weak, and inconspicuous; ovipositor short and weak. Color rusty-gray brownish upon sides, and pale yellowish upon last two segments.

Described from two females.

Cotype.—Cat. No. 6324, U.S.N.M.

Male.—Length 0.66 mm. (0.58 to 0.78 mm.); width of mesothorax 0.23 mm. (0.19 to 0.25 mm.). General color of head and prothorax grayish or yellowish brown; pterothorax abruptly pale yellowish, shading through gray to chestnut brown upon last two abdominal segments.

Head as wide as long, without ocelli; relative lengths of antennal segments as follows:

1	2	3	4	5	6	7	8
4.4	5.9	5.9	5.9	5.2	7.9	2.2	2.6

Prothorax one and one-third times as long as head, and one and one-half times as wide as long; mesothorax one and one-sixth times as wide as prothorax; wings wanting; terminal two segments conoid; spines thereupon slightly more prominent than in female.

Described from seven males.

Cotype.—Cat. No. 6324, U.S. N.M.

Food plant.—*Panicum capilare.*

Habitat.—Amherst, Massachusetts.

Life history unknown.

CHIROTHRIPS OBESUS, new species.

Plate II, figs. 21, 22.

Female.—Length 0.78 mm.; width of mesothorax 0.29 mm.; width of abdomen 0.275 mm. General color of head and thorax yellowish brown; abdomen pale yellow.

Head very small, as wide as long, narrowed anteriorly, much elongated between the eyes, acuminate between basal segments of antennæ. Eyes dark, relatively large, occupying sides of head from close to base of antennæ almost to posterior edge of head; distance between eyes one-half the width of head; ocelli rather small and placed very far back between hind edge of eyes; anterior angle of triangle formed by ocelli is very obtuse; color pale yellow, margined inwardly, or entirely surrounded by red patches. Mouth cone very short and blunt; maxillary palpi short, three segmented. Antennæ one and three-fourths times as long as head, situated upon the elongated portion thereof; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
4.5	6	7	6.5	6	8.3	2.8	3

First segment much compressed longitudinally; transverse diameter more than twice its length; two very strongly drawn out externally into a stout, conical elongation; segments three, four, and five rounded; three with a quite long peduncle; three and four each bear one stout, transparent sense cone upon outer angle. Color of one and two clear pale yellow; three to six becoming gradually more brownish; six to eight uniformly chestnut brown.

Prothorax one and one-third times as long as the head; anterior edge but slightly wider than hind edge of head; sides slightly concave, divergent so that width at posterior edge is more than twice that at anterior edge; hind angles acute, without long spines; sides quite deeply indented above fore coxæ. Sides of mesothorax rounded, converging anteriorly; metathorax narrower than mesothorax, its sides also rounded but converging posteriorly. Color of thorax light yellowish brown, sometimes splashed with red. Fore legs very short and extremely thickened; other legs short, but not thickened. Legs pale yellow, middle and hind tibiæ slightly brownish on upper side, basal part of fore femora shading to light brown. Wings long, sabre-formed, overreaching tip of abdomen, shaded with gray. Two long veins, the hind one branching from the fore at about one-third the length of the wing; both veins disappear before reaching the apex. Each vein bears four to six spines; basal third of wings unfringed; fore fringe sparse, long and slender.

Abdomen ovoid, acuminate at apex, broadly attached to metathorax, one and two-thirds times as long as broad. Spines upon last two segments very short and weak, and those upon ventral plates weak and inconspicuous. Ovipositor very short and weak, apparently not functional; tenth segment split open above. Color of abdomen uniformly clear pale yellow, except apex brownish and posterior edges of segments faintly brownish, receptaculum seminis over base of ovipositor bright reddish orange.

Described from three specmens.

Cotype.—Cat. No. 6325, U.S.N.M.

Male unknown.

Food plants.—*Festuca ovina*, *Poa pratensis.*

Habitat.—Amherst, Massachusetts.

Genus LIMOTHRIPS Haliday.

Body powerful. Head longer than wide, broadened behind, and in front of the eyes extending into a triangular projection upon which the antennæ are borne. Ocelli present in females, but wanting in males. Antennæ eight segmented; third segment drawn out into a blunt, triangular process at outer angle. Maxillary palpi two segmented (*L. cerealium* three?). Prothorax somewhat shorter than the head, slightly broadened at hind edge; hind angles provided with

one long, stout spine. Legs rather short and thick. Wings quite long and of medium breadth; costa bearing a fringe; veins bearing a few short spines. Terminal segment of abdomen in female elongated somewhat and approaching a tubular form, split open above; each side bears a short, extremely stout spine and similar stout spines are borne upon the sides of the eighth segment.

Male entirely wingless. End of abdomen bluntly rounded; ninth segment bears a stout spine at middle of each side and a pair of similar spines stands closely together near the dorsal line above.

Species of this genus move slowly and have no power of leaping.

I found only the new species *avenæ* of the genus.

LIMOTHRIPS AVENÆ, new species.

Plate I, figs. 10–12; Plate II, fig. 13.

Female.—Length 1.57 mm. (1.48 to 1.66 mm.); width of mesothorax 0.28 mm. (0.26 to 0.30 mm.). Form elongated, slender. General color dark yellowish brown.

Head a little longer than wide, tapering a little anteriorly; cheeks very slightly arched; surface of head not at all, or but very faintly, cross striated and bearing a few scattered minute spines; front strongly arcuate, produced considerably between bases of antennæ; color of head dark brown. Eyes of moderate size, black with yellow margins, triangular above, protruding slightly; ocelli fairly well separated, anterior one smallest, pale yellow with very dark red crescents on inner margins. Mouth cone short and moderately thick; maxillary palpi short, only two segmented. Antennæ rather short, about one and one-half times as long as the head, considerably separated at bases; relative lengths of segments as follows:

$$\frac{1}{4.4}\quad\frac{2}{9.1}\quad\frac{3}{11.8}\quad\frac{4}{10.2}\quad\frac{5}{10.5}\quad\frac{6}{14.4}\quad\frac{7}{3}\quad\frac{8}{3.8}$$

Segment one much wider than long; two cup-shaped; three to five clavate; six fusiform; seven and eight slender, cylindrical; one and two dark brown; three to eight shading gradually from pale brownish gray to more or less dark brown; outer angles of three and four strongly developed (three especially so, though obtuse), and each bears one long pointed sense cone; six also bears one long, slender sense cone on inner side at two-thirds its length.

Prothorax a little shorter than head and about one and one-third times as wide as long; sides diverging from head posteriorly; only one long stout spine at each posterior angle; other spines scattered and minute; transverse margins nearly straight; sides slightly rounded; concolorous with head. Mesothorax about one and one-third times as wide as prothorax; metathorax abruptly narrower; sides nearly par-

allel; pterothorax more or less rusty brown in color. Wings present, quite long and slender, about one-seventeenth as broad in middle as long, tapering gradually from base to tip; two longitudinal veins in fore wing, the second branching from the first at about one-fourth its length; both veins and costa bear a few short, rather stout, dark brown spines: costa about twenty, fore vein about twelve, of which only two stand beyond the middle of the wing; hind vein about nine spines; fore wings dark, smoky gray; hind wings very slightly gray; costal fringes long. Legs rather short, but not thickened; femora and middle and hind tibiæ dark brown; all tarsi, fore tibiæ and extremities of middle and hind tibiæ yellow; fore tibiæ shaded with brown above; hind tibiæ alone bearing stout spines.

Abdomen about two-thirds the length of the body and only about one-fourth as wide as long, almost cylindrical in form; segments not overlapping, width of segments increasing very gradually up to the sixth, then diminishing rapidly; last three segments conoid, prolonged at tip of tenth. Spines on sides of abdomen weak and inconspicuous before the seventh segment; eight bears three or four short, very stout, slightly curved, dark brown spines on each side; nine bears a circlet of long, slender spines; tenth segment split open above, sharply pointed at tip, and on each side above is a short, very stout, straight, dark brown spine reaching but slightly beyond the tip; color of abdomen gray-brown, shading to almost black at tip; connective tissue pale yellow; surface of segments finely reticulated.

Described from eight long-winged females.

Cotype.—Cat. No. 6326, U.S.N.M.

Male. Length 1.05 mm. (1.02 to 1.08 mm.); width of mesothorax 0.22 mm. (0.20 to 0.22 mm.).

Head as broad as long. Ocelli generally wanting, though sometimes vestiges are present. Antennæ only one and one-third times as long as the head; relative lengths of segments:

$$\frac{1}{4} \quad \frac{2}{8} \quad \frac{3}{9.7} \quad \frac{4}{7.7} \quad \frac{5}{7.3} \quad \frac{6}{11} \quad \frac{7}{2.3} \quad \frac{8}{3}$$

Color paler than in female, with more of a yellowish tinge, becoming yellowish brown at tip. Pterothorax without traces of wing pads; the dorsal plates very broad, being as wide as first abdominal segment. Head and thorax yellowish brown; legs yellow; femora and tibiæ considerably shaded with brownish.

Abdomen but little more than twice as long as wide, though segments overlap considerably, giving it a yellowish brown and dark-brown cross banded appearance; bluntly rounded at tip; segment nine very large and bluntly conoid; segment ten small, cylindrical, and plainly visible retracted within the ninth; copulatory apparatus projecting a little from ten. Close together in middle of nine above stand two extremely short blunt spines borne upon broader black, chitinous

projections, the inner edges of which are parallel and the black marking tapers to a point anteriorly; on each side of these peculiar processes stands a long, slender spine; at about the middle of each side of ninth segment is a very abrupt, angular, chitinous projection shaded almost black, supporting on the inside of it an exceedingly short, stout, dark brown, blunt spine; other spines on this segment slender, but not very long. Segment ten is blunt at end and bears a row of short, small spines above, close to hind edge; nine is cut out on upper side over about half of ten, which at tip does not quite reach to tip of nine or under side; abdomen yellow-brown.

Described from four specimens.

Cotype.—Cat. No. 6326, U.S.N.M.

Food plants.—Oats, *Festuca pratensis.*

Habitat.—Pennsylvania, Massachusetts.

Life history unknown.

This species was very abundant upon and caused much damage to oats at State College, Pennsylvania, during the summer of 1898.

Genus SERICOTHRIPS Haliday.

Body broad and having a silky luster due to the presence of numerous minute spines on the abdominal segments. Head fully one and one-half times as wide as long. Eyes large and protruding; ocelli present in both sexes. Antennæ eight segmented. Maxillary palpi three segmented. Prothorax much longer than the head, without long spines at hind angles (one present in *S. variabilis*). Legs, especially hind pair, quite slender. Wings either reduced or fully developed; when present, the fore wing is broad at basal fourth, the remainder being very narrow; only one longitudinal vein developed; fore fringe long; spines on veins numerous and moderately developed. Abdomen in some species strongly arched and its segments broad and short; tip of abdomen conical in both sexes. Abdomen of male much more slender throughout.

Species of this genus leap readily.

The characters of this genus are extended to include the following species:

SYNOPSIS OF SPECIES.

Body nearly black except segments four, five, and six of abdomen almost white; wings reduced .... *cingulatus* (p. 141)

Body yellow with brown or gray markings; wings present and with two spines on last fourth, where hind vein usually is .... *variabilis* (p. 143)

SERICOTHRIPS CINGULATUS, new species.

Plate III, figs. 27–29.

Female. Length 1 mm. (0.84 to 1.25 mm.); width of mesothorax 0.25 mm. (0.22 to 0.31 mm.); width of abdomen 0.37 mm. (0.31 to 0.45 mm.). General color very dark brown; abdomen cross-banded with white in the middle.

Head narrow as compared with following segments, one-half as long as wide, widest through the eyes and constricted considerably behind them, neck like and sunken slightly in the prothorax; front slightly depressed at the insertion of the antennæ. Eyes small, rounded, strongly protruding, occupying together only one-half the width of the head, black, coarsely granulated; margins light yellow; ocelli present, very small, well separated, not prominent; anterior one indistinct. Color of head brown; surface bearing scattered small curved spines. Mouth cone reaching to about the posterior edge of prosternum; maxillary palpi three segmented. Antennæ very nearly as long as head and thorax together, slender, eight-segmented; relative lengths of segments:

$$\frac{1}{5.8}\quad\frac{2}{9.9}\quad\frac{3}{16.4}\quad\frac{4}{14.5}\quad\frac{5}{12.2}\quad\frac{6}{14.3}\quad\frac{7}{3.2}\quad\frac{8}{4.}$$

Basal two segments thickest; spines slender and inconspicuous. Segments one, two, and three light yellow; third shaded with brown toward apex; remainder dark brown except four, which is yellowish at base and style is somewhat lighter brown.

Prothorax nearly twice as long as head and one and one-half times as broad as long; widest in middle, tapering abruptly to the head and less abruptly to posterior angles; surface marked with deep, transverse, reticulating wrinkles appearing like striæ in dorsal view; each anterior angle bears a pair of short, divergently curved spines; one short, anteriorly curved spine at each hind angle; color dark brown. Meso and metathorax together scarcely as long as prothorax, only slightly wider than prothorax; yellowish brown, except notal plates dark brown; sides of metathorax not converging posteriorly; metanotum much wider than long. Wings reduced, the pads reaching only to the first abdominal segment. Fore and middle legs of approximately same length; fore pair thicker; hind pair longest and quite slender; all femora shaded with brown in middle but lighter at extremities; tibiæ yellowish brown, more yellow at basal attenuations, fore pair lightest; tarsi uniformly yellowish, slender, and tapering evenly from their bases to tips. Surface of all femora and tibiæ thickly covered with transverse ridges; spines upon hind tibiæ especially long and slender.

Abdomen very large, acutely ovoid, about one-half as broad as long, uniformly thickly covered with minute spines which appear most clearly as a fine fringe at posterior edge of each segment; a transverse dorsal row of about twelve quite uniformly long, brownish spines regularly spaced across the middle of segments two to six, and six similar spines stand in as many small, dark depressions along the posterior edge of the sternal plates of these segments. First three abdominal segments light brown; four, five, and six abruptly pale gray, or yellowish gray, tinged with brown in middle of dorsum, most broadly on sixth segment; last four segments again abruptly dark brown. A narrow, dark-brown, transverse, chitinous thickening

(appearing as a stripe) extends across two-thirds of the width of the dorsal plates of segments two to seven near their anterior edges; spines upon terminal segments short and weak.

This species possesses a well-developed power of leaping.

Described from twenty specimens.

Cotype.—Cat. No. 6327, U.S.N.M.

Male.—Length 0.87 mm. (0.66 to 1 mm.); width of mesothorax 0.21 mm.; width of abdomen, 0.27 mm. (0.22 to 0.30 mm.).

Relative lengths of antennal segments:

$$\frac{1}{5.8}\quad\frac{2}{9.3}\quad\frac{3}{15}\quad\frac{4}{12.8}\quad\frac{5}{10.3}\quad\frac{6}{12.8}\quad\frac{7}{2.8}\quad\frac{8}{3.7}$$

End of abdomen shaped as in female; a transverse elliptical depression in the middle of ventral plates of segments five to seven. Segment nine long and tapering; tenth elongate and retracted within the ninth. Genital apparatus appears to be wholly protrusile. Testes large and brownish yellow in color.

Cotype.—Cat. No. 6327, U.S.N.M.

Food plants.—Various grasses.

Habitat.—Amherst, Massachusetts.

Life history unknown.

SERICOTHRIPS VARIABILIS (Beach).

Plate II, fig. 23; Plate III, figs. 24–26.

Thrips variabilis BEACH, Proc. Iowa Acad. Sci., 1895, III, 1896, pp. 220–223.

Female.—Length 0.84 to 1.23 mm.; width of mesothorax about one-fourth the length of the body. General color yellow, with more or less striking brown or gray-brown markings.

Head about two-thirds as long as broad, broadest through eyes, retracted considerably into prothorax; cheeks moderately full, converging somewhat posteriorly; anterior margin nearly straight, but slightly elevated between bases of antennæ. Spines upon head inconspicuous; but one moderately long spine on each side of fore ocellus, and one behind each hind ocellus; a row of four short, strongly curved spines across front near margin, and a few small spines upon cheeks; color of head pale yellow with dusky shadings. Eyes moderately large, protruding a little, nearly black, coarsely faceted, plainly pilose, occupying about three-fifths the width of the head; ocelli large, approximate, reddish orange, heavily margined inwardly with maroon, situated upon a slightly raised area between the eyes. Mouth cone tipped with black; maxillary palpi slender, three segmented. Antennæ eight segmented, more than twice as long as head, bases separated by about two-thirds the width of a basal segment; relative lengths of segments:

$$\frac{1}{5}\quad\frac{2}{8.2}\quad\frac{3}{12.7}\quad\frac{4}{12}\quad\frac{5}{10}\quad\frac{6}{11.7}\quad\frac{7}{2.7}\quad\frac{8}{3}$$

Segment one nearly spherical and slightly narrower than two which is broadest; three and four fusiform; five similarly formed to four at its base, but quite broad at its apex, and rather broadly joined to six which with style tapers gradually to tip. Color: One white and nearly transparent; two pale or brownish yellow; three and four pale yellow; three light brownish at tip and four in outer half; remainder of antenna light to dark brown, base of five somewhat lighter.

Prothorax about three-fourths as long as wide, a little longer and a little wider than the head; sides about parallel; angles rounded; transversely striated on dorsum; only one long, slender spine at each hind angle; anterior third of pronotum concolorous with head, remainder marked with a saddle-shaped patch of brown, the anterior edge of which is concave and sharply defined; six or eight medium-sized spines stand in this dark border, behind it there are six more or less well-defined brown spots. Pterothorax large and apparently symmetrically formed on account of first segment of abdomen being closely joined to metathorax and closely approaching it in color; meso and metathorax equally wide and about one and one-half times as wide as the prothorax; metanotal plate light brown; rest of pterothorax bright or dusky yellow, except small brown spots at anterior edge of mesonotum and at anterior angles. Wings long, reaching to tip of abdomen; fore wings very slender beyond the basal fourth, breadth at middle only about one twenty-sixth their length; only the fore longitudinal vein is fully developed, though vestiges of the hind vein may be seen at the base. Spines upon costa and fore veins dark brown and conspicuous; twenty-two to thirty on costa; twenty to twenty-six on fore vein placed at regular intervals; two isolated spines stand upon the last fourth of the wing on the line where the hind vein might be expected; the scale bears four spines along its inner edge and one discal near its base. Fore wings uniformly dusky or marked with three white and two gray-brown cross bands alternating; scale also gray-brown; anterior fringe long and fine on outer two-thirds of costa. Legs, especially hind pair, quite long and slender; general color pale yellowish with brown markings on fore femora above, both outer and inner sides of fore tibiæ, around outer halves of middle and hind femora, around middle of these tibiæ, and bases of all bladders. Tarsi slender and tapering; hind tibiæ without stout spines within.

Abdomen cylindrical, tapering sharply from anterior edge of eight, or acute ovoid; two to two and one-third times as long as broad; thickly clothed with minute slender spines appearing most prominently as a fringe on hind edges of dorsal plates. Eight to ten spines upon each segment from two to eight, two or three of these stand quite closely together in a group upon each side, and the middle pair stand very closely together upon segments two to five, but separate more widely upon following segments and become larger; spines upon last two seg-

ments short, weak, and not strongly radiating. Segments two to seven marked with a very prominent dark-brown cross line at anterior third of each; on each side of these segments behind this line is a more or less extensive brown shading which on seven extends clear across the back; ground color of these segments is white or pale yellowish gray; eight, nine, and ten are without the brown markings, and are pale or dusky yellowish.

Male. Similar to female with the following exceptions: Length 0.64 mm.; width of thorax 0.19 mm.; abdomen only four-fifths as wide as thorax, and more than twice as long as wide, nearly cylindrical to seventh segment; eight to ten conoid; spines upon last segment short; the testes large and brownish orange.

Relative lengths of antennal segments:

$$\frac{1}{4} \quad \frac{2}{7} \quad \frac{3}{10.3} \quad \frac{4}{10} \quad \frac{5}{9} \quad \frac{6}{10.5} \quad \frac{7}{2} \quad \frac{8}{3}$$

Var. a. female.—Head and front third of prothorax clear, pale yellow; pterothorax darker yellow; hind part of prothorax and metanotum abruptly brown; abdomen pale yellowish with very conspicuous dark brown cross-streak at first third of segments two to seven; on each side behind this streak is a narrow brown shading which upon seven extends clear across the back. Fore wings slightly tinged with yellowish, darkest at base. Brown spot on femora above, darkest on hind femora. Abdomen acute ovoid.

Food plants.—Clematis, clover, elm, hackberry.

Habitat.—Iowa, Massachusetts.

"*Var. b. male and female.*—Body pale yellowish, immaculate; apical joints of antennæ black, remainder pale; wings and fringes tinged with yellowish."—Beach.

Food plants.—Hawthorn, hackberry.

Habitat.—Iowa.

"*Var. c. male and female.*—Wings nearly uniformly fuliginous; last three joints of antennæ, distal half of joints 4 and 5 black, sometimes intermediate altogether dusky; brown markings very distinct, confined to two large spots on thorax and scutellum respectively, the latter oblong and approximating posteriorly; abdomen immaculate." Beach.[a]

Food plants.—Hawthorn, hackberry.

Habitat.—Iowa.

"*Var. d. male and female.*—This variety is characterized by having the wings fuliginous, trifasciate with white bands, and in being more

[a] I have seen and studied the specimens of Miss Beach labeled "*Thrips variabilis* Beach, Var. c. male and female types." These specimens seem to me to fit much better her description of "Var. d." An emended description based upon these specimens would not be distinguishable from the foregoing description of "Var. d."

heavily marked with brown: the markings on the thorax and bands at bases of first, second, and third (sometimes of second and third only), and seventh and eighth segments of the abdomen are extended until they coalesce and form broad bands; the dorsal surface of the head is brown; sometimes all of the caudal segments are brown; the legs are white, with brown streaks on dorsal surface of femora, and frequently on tibiæ also; antennæ same as in preceding variety." Beach.

Food plants.—Cucumber, grass, smartweed.

Habitat.—Iowa, Massachusetts.

PSEUDOTHRIPS, new genus.

Head much broader than long. Ocelli present. Maxillary palpi three segmented. Antennæ eight segmented (apparently nine segmented, owing to an apparent division of the sixth segment). Prothorax much longer than head and somewhat broadened posteriorly; one stout spine at each hind angle. Wings with two longitudinal veins which, with the costa, are thickly and regularly set with quite prominent spines; fore fringe well developed. Abdominal segments two to eight, inclusive, bear across the middle of each dorsal plate four weak spines, of which the middle two are close together upon anterior segments but diverge posteriorly.

This genus is erected for the single species *inequalis*.

(*ψευδω*, false; *θριψ*.)

PSEUDOTHRIPS INEQUALIS (Beach).

Plate III, figs. 30–32.

Thrips inequalis Beach, Proc. Iowa Acad. Sciences, 1895, III, (1896), pp. 223–224.

Female.—Length 0.88 mm.; width of mesothorax, 0.22 mm.; general color yellow; thorax and abdomen tinged with orange.

Head fully one and one-half times as broad as long, slightly constricted at hind edge, and retracted into the prothorax somewhat; cheeks full; anterior margin nearly straight. Eyes of medium size, rounded, slightly protruding, slightly pilose; ocelli large, well separated, with orange-red margins; ocellar bristles present, but not very long or prominent. Mouth cone moderately sharp and somewhat shaded with brown at tip; maxillary palpi three segmented. Antennæ over two and one-half times as long as head; eight segmented, though there appear to be nine segments; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
4	7	8.5	8.5	8	8+2	2	3

Segment six has a distinct annulation around it at four-fifths its length, the outer part appearing much like a separate segment. Segments one and two quite stout and rounded; three irregularly, and four regularly clavate; seven and eight cylindrical. Segment one paler than two, concolorous with head; three to six pale yellow in

basal parts, shading to dark brown toward the tips; seven and eight dark brown; spines distinct but not prominent, becoming more slender toward the tip.

Prothorax about one and one-half times as long as head, and one and one fourth times as broad at posterior edge; sides nearly straight, diverging backward; dorsal surface bearing a number of small, dark spines, mostly near lateral and posterior borders; one stout, prominent spine at each hind angle. Mesothorax over one and one-half times as wide as head; sides rounded and converging anteriorly; fore angles prominent. Metathorax but little narrower than mesothorax; its sides nearly parallel, curving inward abruptly at hind angles. Wings reaching almost to tip of abdomen; two longitudinal veins quite prominent; both veins and costa thickly and regularly set with prominent dark brown spines: costal twenty-four to twenty-eight, fore vein eighteen to nineteen, hind vein ten to eleven, scale five, internal one. Fore wing about one-fifteenth as broad in middle as long, shaded faintly yellowish; costal fringe well developed. Legs dusky yellow, quite slender; fore femora slightly thickened; femora and tibiæ bearing numerous short spines; inner side of hind tibiæ with but few stouter spines except one pair at tip; each hind tarsal segment with one stout, dark spine on the side; a dark brown spot on under side of each tarsus at tip.

Abdomen elongate-ovate; few dark spines along the sides; segments two to eight bear across the middle of each dorsal plate four weak spines, the middle two are close together upon anterior segments, but diverge posteriorly; posterior edge of nine bears a circlet of six stout spines, the median pair being only slightly more than half as long as the others. All spines on body, and spines and fringes on wings conspicuously dark brown; abdomen dusky yellow, dark brown at extreme tip.

Redescribed from one female, "Type" of Miss Beach.

Male unknown.

Food plant.—Aster.

Habitat.—Ames, Iowa.

This species bears a close general resemblance to *Euthrips tritici*, with which it was taken.

Genus EUTHRIPS Targioni-Tozzetti.

PHYSOPUS.[a]

Ocelli usually present but sometimes more or less rudimentary. Antennæ eight segmented. Maxillary palpi three segmented. Pro-

[a] The name *Physapus* was used by Amyot and Serville for this genus in 1843, but it can not hold, as this name was previously used by Leach for a genus of the Neuroptera in 1817.

I have been unable to see Targioni-Tozzetti's characterization of his genus *Euthrips*, but as nearly as I can tell it may include the species which have been placed in the genus *Physopus*, and I therefore adopt it for this genus.

thorax as long or somewhat longer than the head, with two long spines upon each hind angle and one similar spine upon each anterior angle in many species, but this is wanting in others. Legs usually unarmed, but in a few species with a stout tooth on under side of fore tibia at end. Wings usually fully developed but sometimes reduced. When present they are moderately broad, have two longitudinal veins which are set with numerous stout spines at regular intervals in those species having a spine at the fore angle of the pronotum. Spines upon abdomen moderately stout; anal spines long and slender.

These species are active and can spring.

SYNOPSIS OF SPECIES.

1	General color of body yellow	2.
	General color of body brown	3.
2	Fifth antennal segment about five-sixths as long as four	*occidentalis* (p. 152).
	Fifth antennal segment about two-thirds as long as fourth	*tritici* (p. 148).
3	Antennæ about three times as long as head	*fuscus* (p. 154).
	Antennæ but slightly more than twice as long as head	*nervosus* (p. 155).

EUTHRIPS TRITICI (Fitch).

WHEAT THRIPS.

Plate IV, figs. 36–39.

Thrips tritici FITCH, Count. Gent., VI, Dec. 13, 1855, p. 385.
Thrips tritici FITCH, Rept., II, Nox. Ins. N. Y., 1857, pp. 304–308.
Thrips tritici ASHMEAD, Orange Insects, 1880, p. 72.
Thrips tritici OSBORN, Canad. Entom., XV, 1883, pp. 152, 156.
Thrips tritici OSBORN, Trans. Iowa St. Hort. Soc., XVIII, 1883–1884, pp. 520–521; Coll. Bull., 2, Iowa Agrl. College, 1885, pp. 96, 97.
Thrips tritici HUBBARD, Ins. Affect. Orange, 1885, p. 164, fig. 77, pl. XI, fig. 5.
Thrips tritici FORBES, Centralia, Ill., Sentinel, 1887; Prairie Farmer, June 4, 1887.
Thrips tritici LINTNER, Cult. and Count. Gent., LII, June 9, 1887, p. 459.
Thrips tritici WEED, Prairie Farmer, LIX, 1887, p. 343; Trans. Ill. St. Hort. Soc., 1887, pp. 230–233.
Thrips tritici OSBORN, Insect Life, I, 1888, p. 141.
Thrips tritici WEED, Popular Gardening, III, 1888, p. 176.
Thrips sp. COMSTOCK, Bull. XI, Cornell Agr. Exp. Sta., 1889, p. 131.
Thrips tritici RILEY-HOWARD, Insect Life, I, 1889, p. 340.
Thrips tritici FORBES, 16th Rept. St. Entom., Ill., 1890, p. ix, pl. v, fig. 4; 17th Rept. St. Entom., Ill., 1891, pp. xiii, xv.
Thrips tritici WEED, Ins. and Insecticides, 1891, p. 95.
Thrips tritici FORBES, Insect Life, V, 1892, pp. 126, 127.
Thrips tritici WEBSTER, Bull. 45, Ohio Exp. Sta., 1892, pp. 207, 208.
Thrips tritici TOWNSEND, Canad. Ent., XXIV, 1892, p. 197.
Thrips tritici BRUNER, Rept. Nebr. St. Bd. Agr., 1893, (1893), p. 457, fig. 96.
Thrips tritici BRUNER, Nebr. St. Hort. Rept., 1894, (1894), pp. 163, 214, fig. 82.
Thrips tritici ASHMEAD, Insect Life, VII, 1894, p. 27.
Thrips tritici CRAW, 4th Biennial Rept. St. Bd. Hort., Calif. for 1893–94, 1894, p. 88.
Thrips tritici WEED, Ins. and Insecticides, 1895, p. 146.
Thrips tritici UZEL, Mon. d. Ord. Thysanoptera, 1895, pp. 220, 278.
Thrips tritici SMITH, Economic Entom., 1896, p. 102, fig. 73.

Thrips tritici Lintner, 11th Rept. N. Y. St. Entom., 1896, pp. 247–250.
Thrips tritici Rolfs, 10th Ann. Meet. Fla. St. Hort. Soc., 1897, p. 97.
Thrips tritici Quaintance, Bull. 42, Fla. Agr. Exp. Sta., 1897, pp. 552–564.
Thrips tritici Powers, Fla. Farmer and Fruit Grower (editorial), March 27, 1897.
Thrips tritici Quaintance, Bull. 46, Fla. Agr. Exp. Sta., 1898, pp. 77–103, figs. 1–9.
Thrips tritici Howard, Bull. 18, N. S., U. S. Dept. Agri., 1898, p. 101.
Thrips tritici Rolfs, 11th Ann. Meet. Fla. St. Hort. Soc., 1898, pp. 34–38.

Female.—Length about 1.22 mm.; width about 0.26 mm. General color brownish yellow, thorax tinged with orange.

Head three-fourths as long as broad and four-fifths as long as prothorax, but slightly withdrawn therein; cheeks but slightly arched behind the eyes and converging slightly posteriorly; anterior margin very nearly straight; back of head transversely striated. Eyes large, dark, and slightly pilose, occupying together about three-fifths the width of the head; ocelli present, sub-approximate, pale yellow, margined inwardly with bright reddish orange crescents; spines between ocelli on each side long and conspicuous; post-ocular spines shorter. Maxillary palpi three segmented. Antennæ nearly two and one-half times as long as the head; relative lengths of segments:

1	2	3	4	5	6	7	8
6	8.7	13	12.3	8.8	12.5	2.2	4

Color: One pale yellow; two light brown, base sometimes yellowish; three light yellow in basal half, remainder shaded light brown; four and five brown, yellowish at bases; six, seven, and eight brown. Spines upon antennal segments, especially two to five, quite stout and conspicuous.

Prothorax rather rounded, three-fourths as long as broad; one pair of stout spines at each angle, also one short anteriorly directed spine standing close to lower one of each fore pair; between each posterior pair and median line stands a row of five spines, number four alone being large; color of prothorax pale orange-yellow. Mesothorax rounded at anterior angles; mesonotal plate with one stout spine at each lateral angle and two pairs of small spines on posterior margin. Metathorax tapering but slightly posteriorly; metanotal plate bearing four spines close together at anterior edge, the middle pair being much more stout and conspicuous. Wings nearly reaching the end of abdomen; breadth at middle about one-twelfth their length; shaded but slightly; each fore wing has two longitudinal veins extending from base to tip of wing; spines on veins at regular intervals; costa twenty-six to twenty-eight; fore vein twenty to twenty-two; hind vein fifteen to eighteen; scale five, interior of scale one; a light, sparse fringe on costa of each wing; posterior fringes heavy and wavy. Legs clear pale yellow, sometimes slightly shaded with light brown above, quite thickly set with short brown spines; a pair of stout spines at extremity of each tibia; rows of spines on inner side of hind tibiæ rather weak.

Abdomen cylindrical-ovate, pointed at the apex; dark brown stripe across segments two to seven near their anterior edges; dorsal plates, except nine and ten, shaded more or less with brown; three or four moderately stout brown spines stand out prominently upon the pale yellow sides of segments two to eight; terminal spines long, stout, and dark colored; tip of abdomen dark brown.

Redescribed from eight females.

Male.—Length about 0.7 mm. (0.64 to 0.80 mm); width of mesothorax 0.195 mm. (0.18 to 0.22 mm.). General color pale yellow, darkest upon pterothorax.

Eyes somewhat smaller than those of female. Antennæ about two and one-third times as long as the head. Relative lengths of segments as follows:

$$\frac{1}{4.3}\quad\frac{2}{8}\quad\frac{3}{11}\quad\frac{4}{10.3}\quad\frac{5}{7.9}\quad\frac{6}{10.1}\quad\frac{7}{1.6}\quad\frac{8}{2}$$

Wings large and reaching beyond the tip of the abdomen. End of abdomen (ninth segment) bluntly conical; tenth segment retracted and not reaching the tip of the ninth; nine bears four pairs of long, stout, dark spines, of which one pair stands on each side near the anterior end of the segment, and one pair on each side near the tip; near the middle above stand two short spines.

Described from four specimens.

Food plants.—Alfalfa, apple, asparagus, aster (cultivated), bindweed, blackberry, buttercup, canna, cherry, clover, cone-flower, dandelion, dog-tooth violet, English pea, goldenrod, grasses, hardhack, heal-all, heliotrope, honeysuckle, hydrangea, lilies, mesquite, orange, pea, peach, pear, pink, plum, potato, raspberry, red clover, rose, shrubby *Althæa*, smartweed, *Solidago bicolor*, *Spiranthes simplex*, squash, strawberry, sunflower, sweet william, wheat.

Habitat.—California, District of Columbia, Florida, Illinois, Iowa, Massachusetts, New Hampshire, New Jersey, New Mexico, New York.

The following descriptions of early stages are taken from Quaintance:[a]

Egg.—Size 0.25 by 0.1 mm.; clear whitish in color; oblong, curved in shape.

Larva, first stage.—Length about 0.5 mm.; width of thorax nearly 0.1 mm.; body fusiform, gradually tapering caudad from fifth or sixth abdominal segment. Color, clear whitish; eyes reddish. Antennæ distinctly four-jointed; basal joint cylindrical, short; second somewhat urn-shaped, with distinct distal rim, about as long as broad; third joint conical, apex of cone united to second; fourth fusiform, widest near basal fourth, quite as long as other three joints together. Joints two, three, and four ringed, two and three rather obscurely, but on fourth joint the rings are quite pronounced, where, on distal part, they

[a] Bull. 46, Fla. Exp. Sta.

appear to divide the joint into short, cylindrical segments. On the fourth joint the rings are minutely setate. Numerous large setæ are also present on all joints, most numerous on fourth. Legs stout; hind femur about as long as tibia; tarsus one-jointed, terminating in claw-like fork; bladder-like expansion of adults apparently wanting. Abdomen composed of ten segments, marked dorsally with four longitudinal rows of setæ and a row on each side. All of these setæ appear to be somewhat enlarged and rounded distally, except one pair on dorsum of last segment. On tenth segment these setæ are quite long, being from two to four times longer than the others.

Larva, second stage.—Length about 1 mm.; width of thorax about 0.22 mm.; shape about as in stage one. Color of body deep orange yellow; legs and antennæ lighter; eyes reddish; antennæ four-jointed, as in first stage; basal joint short, cylindrical, about one-half as long as wide; second, subcylindrical, somewhat longer than wide; third, subconical, about a third longer than wide; fourth, about as long as proximal three together, fusiform, thickest about basal fourth. Joints three and four plainly ringed, the rings of fourth joint quite distinct and minutely setate, as in first stage. Large setæ are also present about as in stage one. Femur of hind legs about as long as tibia; tarsus one-jointed, somewhat forked distally, and bearing a membranous expansion.

Nymph or pupa, young nymph.—Resembles the full-grown larva in shape; in color it is much lighter, being light yellow, with legs, antennæ, and wing-pads still lighter. Eyes reddish.

In the antennæ, legs and wing-pads the nymph skin appears somewhat as a sheath to these parts of the forming adult. The antennæ are three or four jointed, apparently, thick and clumsy. The basal joint is large, swollen, slightly longer than wide; the second is about twice as long as wide and somewhat constricted in middle. Third joint is about a third longer than second, gradually tapering distally to an obtuse end. When the nymph stage is first entered the antennæ project cephalad in normal position. In six or eight hours, however, they are laid back over the head and prothorax. In the hind legs, femur and tibia of about equal length; tarsus indistinctly one-jointed, very short, and rounded distally. Wing-pads short, scarcely reaching caudal end of second abdominal segment, bearing one or two setæ. Abdomen as in larva, with dorsal and lateral rows of setæ, which, however, are acute. On the dorsum of ninth segment, near caudal margin, are four stubby, hook-like processes, curving cephalad, which appear to be the four modified setæ of this region.

Mature nymph.—Length about 1 mm.; width of thorax about 0.22 mm.; color light yellow; shape very similar to that of adult Thrips. Nymph skin more or less separated from the body of the adult within, particularly so in the legs, antennæ, mouth-parts, wing-pads, and

caudal end of abdomen. The wing-pads reach to about the sixth segment.

Life history.—"The life cycle of *Thrips tritici* is quite short, requiring but twelve days. Eggs are deposited in the tissues of infested plants, and hatch in three days. The larval state lasts for about five days, during which time the insect makes two molts, the second when entering the nymph stage. The nymph stage continues for about four days, during which time they take no food, rarely move to any extent, but remain hidden away."

Economic considerations.—This is one of the most widely spread and generally injurious species in this country. The specimens from which Fitch described the species were taken at Geneva, Wisconsin, from a wheat field which was being injured by the little pests. At various times it has been noticed swarming in the blossoms of orange and causing injury thereto. It is a very common species on a large number of flowering plants, both wild and cultivated, but unless present in great numbers their injuries are likely to pass unnoticed. By far the greatest damage appears to be done to strawberries, in the blossoms of which they swarm, and by their punctures of the essential parts of the flower they prevent its fertilization and the consequent development of the fruit. This failure of bloom, though perhaps produced at times by other insects and in other ways, is known to growers as "buttoning." The most serious injuries have been reported from Florida and Illinois. In Florida the strawberry crop in some sections has been reduced to one-third in dry seasons.

EUTHRIPS OCCIDENTALIS Pergande.

Thrips sp. Coquillett, Ins. Life, IV, 1891, p. 79.
Euthrips occidentalis Pergande, Ins. Life, VII, 1895, p. 392.

Female.—Length about 1 mm.; width at mesothorax about one-fourth the body length. General color head pale lemon yellow, thorax orange yellow, abdomen brownish yellow.

Head about one and one-third times as broad as long, three-fourths as long as the prothorax and considerably withdrawn into the latter. Eyes rather large, occupying together about three-fifths the width of the head, dark, slightly pilose; ocelli subapproximate, pale yellowish, margined with reddish orange crescents; one very prominent spine between ocelli on each side; post-ocular spines very conspicuous. Maxillary palpi three segmented. Antennæ about two and one-half times as long as the head; first segment slightly shorter than the style; two is one and one-half times as long as one; three is longest; four is six-sevenths as long as three; five is five-sixths as long as four; six nearly as long as three; seven very short, about one-fourth as long as five; eight is one and three-fifths times as long as seven. Color of one translucent whitish; two brownish yellow (uniform), basal parts of

three, four, and five pale yellowish; apical parts shading quite abruptly to light brownish; six uniformly brown; style slightly lighter than six. Spines upon antennal segments, especially two to four, are unusually stout and prominent.

Prothorax nearly one and one-third times wide as long; color intermediate between that of head and pterothorax. One pair of prominent, stout spines at each angle; one short anteriorly directed spine close to the lower one of each fore pair; a row of five small spines (the fourth is stoutest) stands on each side of hind margin between pair at angle and median line. Anterior angles of mesothorax rounded; metathorax slightly narrower than mesothorax, its sides nearly straight and parallel; mesonotal plate bears one stout spine at each lateral angle and two pairs of small spines on posterior margin; metanotal plate bears two pairs of spines close to anterior edge, the middle pair being much the stouter; color of pterothorax bright orange. Wings very slightly yellowish; both longitudinal veins extend from base to tip of wing; both internal and the costal veins bear very stout, brown spines set at regular intervals; costa twenty-four to twenty-six, fore vein nineteen to twenty-two, hind vein fifteen to eighteen, scale five, internal on scale one. Fringe upon costal edge is very light, that upon hind edge is long and wavy; cross veins can sometimes be seen between the longitudinal veins and between the fore and costal veins at about two-fifths their length from base and sometimes a third at about four-sevenths between the fore and costal veins. Legs uniformly concolorous with head, bearing numerous small spines; a pair of strong spines at inner side of tip of each tibia.

Abdomen elongate-ovate in outline, conical at apex; a transverse, narrow, brown band extends across anterior part of segments three to seven; brownish tinge on abdomen fades behind sixth segment leaving only the apex of the cone brown; a group of three or four stout spines stands upon each side of segments two to eight; terminal spines long, stout; all spines brown.

Male.—Length about 0.65 mm.; width about 0.17 mm. Lighter in color than the females; nearly a uniform lemon yellow, slightly darker on throax; form more slender; apex of abdomen blunt, terminated on sides by two pairs of long, stout, inward curving spines; ninth segment also bears two pairs of very long, stout spines near its posterior border and near the dorsal line on this segment is a pair of short spines; the brown bands across the abdomen of female are wanting in males and they have fewer spines on sides of segments; the bright orange-colored testes are very prominent.

Food plants.—Apricot, orange, potato, and various weeds.

Habitat.—California.

Redescribed from specimens at the U. S. Department of Agriculture, Division of Entomology—presumably types.

Remarks.—This species is very similar to *Euthrips tritici* (Fitch), but it has a longer though more retracted head, which is also slightly wider; the terminal segment of the antenna is one and three-fifths times as long as seven; spines on body stouter and more prominent. Both *Euthrips tritici* and *Euthrips occidentalis* approach very closely to *Physopus nigriventris* Uzel.

EUTHRIPS FUSCUS, new species.

Plate IV, figs. 40, 41.

Female. Length 0.93 mm. (0.70 to 1.08 mm); width of mesothorax 0.21 mm. (0.18 to 0.24 mm.). General color brown. In dark specimens the abdomen is blackish brown; in light specimens the general color is yellowish brown.

Head about one and one-half times as wide as long, about one-fourth retracted into prothorax; occiput deeply wrinkled transversly; anterior margin of head slightly and smoothly elevated in middle; cheeks straight and parallel. Eyes moderately large, occupying together about one-half the width of the head, dark, slightly protruding; margins pale yellow; ocelli smaller than facets of eye, pale yellow, margined with dark red, widely separated, posterior ones contiguous with yellow margins around eyes; one stout spine in front of each posterior ocellus. Mouth cone short and tapering abruptly; maxillary palpi slender, three segmented. Antennæ inserted a little below the margin, about three times as long as dorsal length of head; relative length of segments:

$$\frac{1}{5.5}\quad\frac{2}{8.8}\quad\frac{3}{10.4}\quad\frac{4}{10.2}\quad\frac{5}{9}\quad\frac{6}{11.7}\quad\frac{7}{2.3}\quad\frac{8}{3.3}$$

First segment rounded, one-third broader than long; two is cup-shaped; three to six subequal in thickness; three to five somewhat clavate; three with very slender peduncle; six cylindrical-ovate. Antennæ quite uniformly brown (sometimes three, four, and five lighter gray-brown, especially at bases), only segment three somewhat more yellowish; spines on segments two to five quite stout and dark colored. Color of head uniform grayish to orange-brown.

Prothorax fully one and one-half times as wide as long and one and two-fifths times as long as the head; sides arched; angles rounded; wider behind than in front; one large curved spine at each anterior angle and another on anterior margin between this and the median line; two stout spines at each posterior angle, the inner one of which is much the weaker; also a stout spine on the posterior edge between the pair and the median line; other spines on prothorax small and not conspicuous. Mesothorax but very little wider than the prothorax; projecting prominences at anterior angles; mesonotum broad, without

prominent spines; posterior edge nearly straight for one-third the width of the segment; metathorax narrows abruptly after the anterior edge till narrower than prothorax, then sides run nearly parallel to abdomen; mesonotum with two pairs of spines near anterior edge, the outer one of each pair being much less stout than the inner one; mesothorax and metathorax together not longer than the prothorax. Wings reduced, barely reaching to the first abdominal segment; pads set with several stout spines. Legs of medium length and of moderate size, quite thickly set with short bristles, concolorous with, or usually lighter than body; bases of posterior femora and inner sides of posterior tibiæ more yellowish; thorax colored nearly like head.

Abdomen one and one-half times as wide as the mesothorax (short-winged female) and twice as long as broad, or nearly twice as long as head and thorax together; elliptical in outline except that apex is conical; broad, dark bands cross the abdomen at the anterior edge of dorsal plates on segments two to eight. Each segment except one and ten bears two or three short, stout spines on sides; in addition to these nine bears a circlet of eight unusually long, strong spines, and ten also bears a circlet of six long spines though these are somewhat shorter than those on previous segment. Segment ten is split open above; color of abdomen yellowish brown to brown-black, usually considerably darker than head and thorax; segments usually more or less telescoped.

Described from eighteen short winged females taken in hibernation in February and November.

Cotype.—Cat. No. 6328, U.S.N.M.

Food plant.—Grass?

Habitat.—Massachusetts.

Life history unknown.

EUTHRIPS NERVOSUS (Uzel).

Plate III, figs. 33, 34; Plate IV, fig. 35.

Physopus nervosa Uzel, Monographie d. Ord. Thysanoptera, 1895, p. 102.

Thrips (Euthrips) maidis Beach, Proc. Iowa Acad. Sciences, 1895, III (1896), pp. 219, 220.

Female.—Length 1.33 mm. (1.22 to 1.39 mm.); width of mesothorax 0.32 mm. (0.28 to 0.34 mm.). General color dark yellowish brown.

Head somewhat pentagonal in form, not as long as wide; cheeks straight and converging slightly posteriorly; front broad and obtusely angular; back of head transversely wrinkled and bearing a few minute spines. Eyes rather small, black with light yellow borders, rounded or oval in outline; ocelli yellow, widely separated, posterior ones contiguous with light borders around eyes; one very long slender spine on each side midway between ocelli. Mouth cone pointed, tipped

with black; maxillary palpi three segmented. Antennæ slightly more than twice as long as head and very slender beyond second segment; comparative lengths of segments as follows:

1	2	3	4	5	6	7	8
6	10	14	12.5	11.4	15.3	3	4

Color of antennæ dark brown, except segments three and four and extreme base of five abruptly yellow. Spines on first segments quite dark and conspicuous, becoming paler and more indistinct toward the tip.

Prothorax approximately as long as head and a little wider, almost rectangular in form, bearing many prominent spines; one at each fore angle and two at each hind angle are longest; one half way between fore angle and median line on front margin and one similarly placed on hind margin are intermediate in size; numerous others are smaller. Color of head and prothorax dark brown. Mesothorax approximately as wide as length of antennæ; front angles obtusely rounded; metanotal plate bears four spines close to front edge, the middle pair being large and prominent, the others small; pterothorax yellowish brown. Wings present, fully as long as the abdomen, about one-twelfth as broad as long, sharply pointed at ends; surface of wings thickly covered with minute, dark-colored spines; both longitudinal veins and costa of fore wing thickly and regularly set with quite long, dark-colored spines; costa has from twenty-five to twenty-nine, fore vein from sixteen to twenty-two, hind vein from fourteen to sixteen; fore wings shaded with gray; veins not prominent; costal fringe of fore wings weak and less than twice as long as costal spines. Legs moderately long, not thickened; femora dark brown, yellow at extremities; tibiæ and tarsi yellow; tibiæ shaded more or less with brown around middle and tarsi with prominent dark brown spot at tip within; each tibia with a pair of prominent, dark brown spines at tip within and a row of from five to seven short brown spines on inner side of hind tibiæ.

Abdomen about two and one-half times as long as width of mesothorax, somewhat cylindrical in shape, but enlarging from base to hind edge of second segment and tapering evenly from eighth segment to tip. Spines along sides and around tip of abdomen very dark brown and conspicuous; those on segments nine and ten are long and subequal on both segments. Color of abdomen dark brown, shading toward tip; connective tissue yellow; last segment split open above.

Redescribed from six females; no males found. Compared and identified with *Thrips* (*Euthrips*) *maidis* Beach.

Food plants.—Corn, various grasses (first spring flowers, Uzel).

Habitat. Bohemia (Uzel); Ames, Iowa; Amherst, Massachusetts.

Life history unknown, except that it hibernates in turf.

SCOLOTHRIPS, new genus.

Head wider than long, retracted considerably into prothorax. Eyes protruding; ocelli present. Maxillary palpi three segmented. Antennæ short and thick; sense cones very long. Prothorax slightly longer than head and somewhat broadened posteriorly. Spines arranged as follows: One at each anterior angle, one halfway between these angles and the median line, one at the middle of each side, two at each hind angle, and one between this pair and the middle of the hind margin. Wings present, slender, with two longitudinal veins and ring vein strongly developed; fore fringe very weak but spines on veins very strong. Intermediate abdominal segments with one spine on each side at the hind angle.

This genus is erected for the species *6-maculatus*.

(ςκωλος, prickly or thorny; θριψ.)

SCOLOTHRIPS 6-MACULATUS (Pergande)

Plate IV, figs. 42-45.

Thrips 6-maculata PERGANDE, Trans. St. Louis Acad., V, 1894, p. 542.
Thrips pallida BEACH, Proc. Iowa Acad. Sciences, 1895, III, (1896), pp. 226-227.

Female.—Length, 0.83 mm. (0.72 to 0.97 mm.); width of mesothorax, 0.21 mm. (0.18 to 0.25 mm.). General color clear pale yellow.

Head about three-fourths as long as wide, frequently considerably retracted within prothorax, even to the eyes sometimes; cheeks straight and parallel; front margin rounded; vertex elevated between the eyes. Eyes large, protruding; posterior ocelli nearly contiguous with margins of eyes; one very long, backwardly curved spine stands in front of each posterior ocellus, and two pairs of curved spines stand upon the margin in front. Maxillary palpi slender, three segmented; labial palpi very long and slender. Antennæ rather short and compact; inserted below front margin; approximate at base, relative lengths of segments:

1	2	3	4	5	6	7	8
4.2	7	7.4	6.7	6.1	9	2.5	3.5

Segment one cylindrical, about two-thirds as thick as two, which is more rounded; seven and eight rather thick. Color of one and two nearly white, the remainder almost uniformly dusky gray; spines on segments two to five long and prominent as are the sense cones; the sense cone on the inner side of six arises below the middle of the segment and reaches beyond the end of the seventh.

Prothorax slightly longer than the head, but only about three-fourths as long as wide, broadened somewhat posteriorly and rounded at hind angles, sides curving gently inward anteriorly; spines extremely long and slender, arranged as follows: One at each anterior angle, one half

way between these and the median line, one at middle of each side, two at each hind angle, and one between this pair and middle of hind margin. Mesothorax about one and one-third times as wide as the prothorax, with one slender spine at middle of each side. Wings long, reaching nearly to tip of abdomen, at middle about one-seventeenth as broad as long, pointed at tips. Fore wing with two longitudinal veins and a very heavy ring vein; hind longitudinal vein branches from the fore vein at about one-third the length of the wing. Spines upon costal and both longitudinal veins very long and stout, fully equaling those upon the anal segments; costal vein bears from fifteen to twenty, fore vein from nine to eleven, hind vein five or six (the third and fourth spines, sometimes the second also, which I have counted as standing upon the fore vein, stand at the same angle to the wing as do those upon the hind vein and really belong thereto, though the veins have united); the front fringe of the fore wings is extremely sparse, short and weak, and does not extend to the tip; hind fringes also unusually short. Fore wings are characterized by three light brownish spots on each—one at base of wing, one immediately beyond separation of longitudinal veins, and the third halfway from the second to the tip of the wing (the third is a band extending clear across the wing). Legs concolorous with body, sparsely set with slender spines.

Abdomen cylindrical-ovate, pointed at extremity, surface smooth; only one spine of any prominence at posterior side angles of segments two to eight; spines upon segments nine and ten not as strong as those upon the wings; color nearly uniformly pale yellow without prominent markings.

Redescribed from ten specimens.

Male.—Male smaller than female, but otherwise agreeing very closely with the foregoing description. Abdomen bluntly conical at tip; tenth segment partially retracted within ninth, which is cut out in last half above the tenth; spines borne on top and sides of nine are shorter and weaker than those on wings.

Described from one specimen.

Food plants.—"Found on many plants infested with red spider, on which it has repeatedly been observed to feed."—Pergande. "Feeding on mites in fold of cottonwood leaf."—Bruner. Taken on bean, blackberry, elm, and hop.—Beach.

Habitat.—Missouri (?); Ames, Iowa; Barraboo, Wisconsin; Lincoln, Nebraska.

Thrips pallida Beach is positively identical with this species, as has been learned from an examination of her types.

Genus RAPHIDOTHRIPS Uzel.

Ocelli present. Antennae eight segmented; the fifth segment short and cut off abruptly at the end so that it joins the base of the sixth by an unusually broad surface; style very slender, composed of two equally

long segments, which are together as long as are the fifth and sixth. Maxillary palpi three segmented. Prothorax a little longer than the head and somewhat broader at the hind than at the fore edge; no long spine at the front angles, but two at each hind angle. Legs unarmed. Wings usually reduced, but when present they are of medium length, and have two longitudinal veins which are set with small spines.

I find here only the new species *fuscipennis*.

RHAPHIDOTHRIPS FUSCIPENNIS, new species.

Plate V, figs. 46–48.

Female.—Length 1.32 mm. (1.20 to 1.66 mm.); width of mesothorax 0.24 mm. (0.22 to 0.27 mm.). General color nearly uniform chestnut brown.

Head as long as wide, but little shorter than prothorax, into which it is retracted a little; anterior margin slightly elevated and rounded; constricted a bit close behind the eyes; cheeks nearly straight behind the constriction and diverging slightly posteriorly so the head is widest at hind edge; back of head finely striated. Eyes quite large, rounded, protruding; margins light; ocelli present, larger than facets of eye, light colored with dark crescentic margins, well separated, but posterior ones not contiguous with margins around eyes; ocellar spines very long and conspicuous; post-ocular spines quite large. Mouth cone extending back to anterior edge of mesosternum, slender, so that head from below appears considerably elongated; labial palpi small; maxillary palpi quite long, slender, and three segmented. Antennæ twice as long as head; relative lengths of segments:

1	2	3	4	5	6	7	8
5.8	9	11	10.3	6.25	10.5	8.2	8.25.

First segment shortest, cylindrical; second cup-shaped; third pedicellate; third, fourth, and sixth are approximately equal in thickness; third and fourth elliptical; fifth constricted at base and increasing in size to apex, where it is cut off abruptly and unites by its entire width to the equally broad base of sixth, which tapers gradually from one-third its length to its apex, where it is but slightly wider than seventh; seventh and eighth slender, cylindrical. Color: First and second uniformly slightly lighter brown than head; third and fourth pale yellow with slight brownish tinge; fifth shading from color of fourth to a little lighter than sixth; sixth, seventh, and eighth gray-brown; spines long and fairly conspicuous.

Prothorax slightly wider than long, widest at posterior angles; sides but slightly arched; no prominent spines at anterior angles; two stout spines stand close together at each posterior angle; surface finely striated and set with a few scattered small spines; bases of spines light

yellowish; pronotum frequently extending considerably over front edge of mesonotal plate. Mesothorax about one and one-third times as wide as the prothorax and considerably wider than metathorax, except at its anterior edge; anterior angles of mesothorax very acute; no conspicuously large spines upon pterothorax. Wings sometimes reduced; when present, long and about one-thirteenth as broad in middle as long; fore wings shaded with gray, pale brownish along veins, clear at base; second longitudinal vein arises at about two-fifths the length of the wing, its origin indistinct. Spines upon all veins quite long and slender, but not thickly set or very conspicuous; costa bears seventeen to nineteen, fore vein eight or nine, hind vein eight or nine. Wing pads, when present, not overreaching the pterothorax. Legs moderately strong, but not thickened; femora and tibiæ dark brown like body; inside of fore tibiæ, extreme tips of the others and all tarsi pale gray or yellow; legs scatteringly set with fine spines, apex of hind tibiæ alone bearing a pair of stouter spines.

Abdomen very long—almost twice as long as head and thorax together—and three times as long as broad, nearly cylindrical, tapering abruptly from anterior edge of eighth segment to the apex; segments overlapping more or less when abdomen contains no eggs; color uniform dark brown without conspicuous markings or spines except those upon two terminal segments, which are quite long and slender.

Described from six females, five of them long-winged.

Cotype.—Cat. No. 6329, U.S.N.M.

Male unknown.

This species agrees very closely in most respects with *R. longistylosa* Uzel, but differs in the following points: Head as wide as long; second antennal segment somewhat shorter than third, fourth, and sixth; fifth segment lighter colored at tip than sixth. Body length, average (exclusive of egg-filled females), 1.25 mm.

Food plant.—Grass.

Habitat.—Massachusetts.

Life history unknown.

Genus ANAPHOTHRIPS Uzel.

Ocelli present. Antennæ eight segmented (apparently nine in *A. striatus*). Maxillary palpi three segmented. Prothorax about as long as head. Legs unarmed. Wings usually present (usually absent in the fall generations of *striatus*), with two longitudinal veins; spines upon veins small and inconspicuous. No stout spines at angles of prothorax; all spines on body short except the anal spines, which are short and slender (in *striatus* they are short and stout).

Males have usually two pairs of very short, stout spines upon the ninth abdominal segment above, of which the anterior pair is stronger than the posterior.

Species of this genus have no power of springing.

In this genus I find only the species *striatus*.

ANAPHOTHRIPS STRIATUS (Osborn).

GRASS THRIPS.

Plate V, figs. 49–51.

Limothrips poaphagus COMSTOCK, Syllabus ot Course of Lectures at Cornell and Peoria, 1875, p. 120.
Limothrips poaphagus LINTNER, Rept. N. Y. Agr. Soc., 1881–82.
Thrips striata OSBORN, Can. Ent., XV, 1883, p. 155.
Limothrips poaphagus FERNALD, Grasses of Maine, 1885, p. 42.
—— —— N. E. Farmer, June 19, 1886.
—— —— LINTNER, 3d Rept. Ins. N. Y., 1887, pp. 96–98.
Limothrips poaphagus COMSTOCK, Introd. to Ent., 1888, p. 127.
Thrips striatus PACKARD, Ent. for Beginners, 1888, p. 73.
—— —— FLETCHER, Ent. Amer., IV, 1888, p. 152.
—— —— HOWARD, Ent. Amer., IV, 1888, p. 152.
Limothrips poaphagus OSBORN, Ins. Life, I, 1888, p. 140.
Thrips striatus PACKARD, Stand. Nat. Hist., 2d ed., II, Append., 1888.
—— —— FLETCHER, 19th Rept. Ent. Soc. Ont., 1888, p. 11.
—— —— FLETCHER, Ann. Rept. Exp. Farms, 1888, pp. 59–62.
Limothrips poaphagus LINTNER, Rept. N. Y. Agr. Soc., 1888.
Phloeothrips poaphagus FLETCHER, 20th Rept. Ent. Soc. Ont., 1889, pp. 2, 22.
—— —— BRODIE, 20th Rept. Ent. Soc. Ont., 1889, p. 8.
Limothrips poaphagus LINTNER, 5th Rept. N. Y. St. Ent., 1889, pp. 153, 304.
—— —— OSBORN, Can. Ent., XXIII, 1891, pp. 93, 96.
—— —— FLETCHER, Ins. Life, V, 1892, p. 124.
—— —— FORBES, Ins. Life, V, 1892, p. 127.
—— —— FLETCHER, Ann. Rept. Exp. Farms, 1892, p. 3.
Limothrips poaphagus COMSTOCK, Man. for Study of Ins., 1895, p. 120.
Limothrips poaphagus UZEL, Mon. d. Ord. Thysanopt., 1895, pp. 279, 435, 446, 448.
Thrips striata UZEL, Mon. d. Ord. Thysanopt., 1895, p. 220.
—— —— HOPKINS-RUMSEY, Bull. 44, W. Va. Agr. Exp. Sta., 1896, pp. 270, 271.
—— —— SMITH, Economic Ent., 1896, p. 102.
—— —— PUTNAM, N. E. Farmer, July 2, 1898.
Anaphothrips striata HINDS, 37th Ann. Rept. Mass. Agr. College, 1900, pp. 81–105, 4 pls., 33 figs.
Anaphothrips striata FERNALD and HINDS, Bull. 67, Mass. Agr. Exp. Sta., 1900, pp. 3–9, pl. I, figs. 1–6.

Female.—Length 1.3 mm. (1 to 1.6 mm.); width of mesothorax 0.25 mm. (0.23 to 0.26 mm.). General color yellow, with more or less dusky or brownish shading upon some parts.

Head very slightly wider than long, rounded in front; cheeks straight and parallel; surface back of eyes faintly striated; head yellow with brown posterior border, without long spines. Eyes small, rounded, black or very deep purplish red; ocelli subapproximate, yellow, with orange-red margins. Mouth cone moderately sharp, and very prominently tipped with black; maxillary palpi three segmented. Antennæ approximate, about twice as long as head, eight segmented, though

apparently nine segmented, owing to the division of the sixth segment by an oblique suture at about three-fourths its length. Relative lengths of segments:

1	2	3	4	5	6	7	8
5	8.5	11	10	10	9.5+3.5	2.25	3.25

Segments one and two rounded; three to six fusiform. One is pale, almost white; two light brown; three lighter than two; three to six shading gradually to dark brown, almost black; spines pale and not conspicuous.

Prothorax but slightly longer and a little wider than the head; sides rounded slightly and without prominent spines. Mesothorax much wider than prothorax; fore angles obtusely rounded. Metathorax quite smoothly joined with mesothorax and tapering gradually to base of abdomen. Wings usually present in summer generations, reduced to mere pads in hibernating females; when present, approximately as long as abdomen, about one-thirteenth as broad as long and tapering gradually; two longitudinal veins in fore wing extending from base to tip; veins quite prominent, being darker than rest of wing. All veins bear a few very small, rather indistinct spines; fringe on fore edge well developed, being nearly half as long as posterior fringe. Fore wings shaded with yellowish gray; hind wings nearly white. Legs of medium length and size; stout spines only on inner side and at tip of hind tibiæ; legs pale yellow shaded with light gray or brown above on femora and tibiæ, and with prominent dark brown spot at tip of tarsi within. Pterothorax darker yellow than rest of body, with row of irregular dusky spots on each side close to middle, curving outwardly at both ends.

Abdomen quite long, cylindrical, widening somewhat at first two segments and tapering from eight to tip; eight to ten sharply conical. Spines on nine and ten short and weak, but dark-colored and quite conspicuous; other spines on abdomen small, pale, and indistinct. Abdomen pale yellow; segments one to seven slightly dusky on top, segment ten shading to dark brown at tip.

Redescribed from six long-winged and four short-winged females. Male unknown.

Food plants.—Poa pratensis and *Phleum pratense.*

I have also found genuine "silver top" upon the following list of grasses at Amherst, Massachusetts, but I can not positively connect this species with all the injury: *Poa serotina*, *P. nemoralis*, *P. compressa*, *P. arachnifera*, *P. fletcheri*, *P. aquatica*, *P. trivialis*, *P. cæsia*, *Agrostis alba*, *A. canina*, *A. stolonifera*, *A. vulgaris*, *Festuca elcoll*, *F. heterophylla*, *F. elatior*, *F. ovina*, *F. duriuscola*, *F. rubra*, *Panicum crus-galli*, *P. sanguinale*, *Elymus striatus*, *E. virginicus*, *Bromus erectus*, *B. inermis*, *Avena flavescens-vera*, *Agropyrum caninum*, *Arrhenatherum avenaceum*, *Lolium perenne.*

Habitat.—Illinois, Iowa, Maine, Massachusetts, New York, Ohio, Ontario.

I have sought in vain for the males of this species, for although I have mounted over a thousand specimens, and have bred many more in bottles in the laboratory, and have taken and examined large numbers of them in the field, I have never seen any that I even suspected were males. A series of experiments begun in the laboratory in July and continued into December showed that no males are developed in the autumn generations. Experiments were begun the following season by obtaining hibernating females before the weather was warm enough for them to move out of doors and confining them in bottles in the laboratory. These became active and deposited eggs, from which succeeding generations developed without the appearance of any males. I conclude, therefore, that this species is parthenogenetic, and reproduces without the intervention of males, at least for a series of generations, in this locality.

The following descriptions are of the early stages:

Eggs.—The eggs are reniform, and vary in length from 0.265 mm. to 0.33 mm. and in width from 0.085 mm. to 0.145 mm. The average dimensions taken from twenty-five eggs are: Length, 0.288 mm.; width, 0.11 mm. The color is a translucent white. By transmitted light the eggs are seen to be filled with a mass of yolk globules which vary considerably in size.

Larva.—As the larva emerges from the egg it is very soft, shiny, and nearly white. The eyes are purplish red in color; the appendages are folded closely against the ventral side of the body. The length soon after emergence is about 0.3 mm. and the width is about 0.1 mm. Body tapers from eighth segment to tip; head is nearly as wide as the thorax. Antennæ are comparatively large, approximate at base, and composed of seven segments, of which the last four are closely joined and appear almost like a single conical segment; fourth segment is larger than any other, and distinctly ringed with whorls of minute hairs; the second and third are indistinctly ringed; basal segment bears one small spine on inner side; two has four spines which are directed forward and one very long spine which is directed backward toward the head; the third bears five short spines, and the terminal part of the fourth and each of the following segments a number of spines, which are quite long and stout. Legs are stout; tarsi one segmented and terminated by two claws. The bladder-like expansion is present. Abdomen much compressed longitudinally and, except the tenth segment, marked with six longitudinal rows of setæ, three pairs to each segment. The four dorsal rows also extend forward along the thorax and head; tenth segment bears six very long setæ—two dorsal, two lateral, and two ventral.

The full-grown larva is fusiform, about 1.2 mm. in length and about 0.3 mm. in breadth, while the width of head is about 0.1 mm. Antennæ

seven segmented, somewhat separated at their base and rather thick for their length; color darker than that of the body, often nearly black; segmentation beyond fourth segment more distinct than in immature larva; first four segments subequal in thickness, and third and fourth nearly equal in length, and each as long as the first and second segments together; last three segments much smaller; fifth shortest. Spines arranged much as in younger stage; third segment distinctly ringed and without setæ. Each segment, except last two, bears short spines which are slightly thickened at their extremities, and arranged as in the young larva; spines on last two segments long and acute. Integument of body roughened by transverse rows of clearly defined ridges. Body marked by dorsal and lateral longitudinal stripes of yellow which are most distinct upon thorax; dorsal stripe widest.

Pupa.—Its general form resembles that of the larva; color of legs, wing pads, and antennæ clear white; thorax and abdomen very light yellow; eyes bright red. When the pupal stage is first entered the antennæ are apparently three or four segmented, much shortened, and directed forward as in the larva; but after a few hours they are laid back upon the head and thorax. Wing sheaths short and developed outside of the body; legs thick and clumsy. Upon dorsal side of ninth segment, near posterior margin, are four prominent, stout, recurved, hook-like processes; abdominal setæ slender and acute. Wing sheaths finally extend to the sixth segment and fore pair bear a few small spines.

Life history.—About 98 per cent of the adults which hibernate are of the short-winged form, while from 90 to 95 per cent of the first generation in the spring develop long wings, and this form predominates until late summer, when the proportion declines, and in October only a small number of winged adults can be found. The females continue to deposit eggs and the young larvæ develop and may be taken from the grass upon warm fall days till snow covers the ground; but so far as I can find, only the adults survive the winter. Hibernating females do not appear to suffer from exposure to a temperature of −21° F., and they may be brought in at any time during the winter by pulling a few handfuls of grass from infested fields and bringing it into a warm room, where the little animals will very soon become lively and begin to crawl. Accidentally it was found that they could survive for several days though completely submerged in a weak solution of potassium hydrate, and they have been found to revive after being frozen solid in a 2 per cent solution of the same; but so far as my experiments went, freezing in pure water killed them. The females become active very early in the spring and the development of eggs begins. As many as eight apparently fully developed eggs have been seen at one time in the body of one of these hibernated females. Ovipo-

sition soon begins, and lasts for from four to six weeks in many cases. They seem to oviposit as readily at night as in daylight. The deposition of an egg requires about one and one-half minutes. The eggs may be readily seen in the leaf by holding it before a light, when they appear as small, lighter spots; they may be easily separated from the leaf by stripping off the epidermis. The length of the egg stage varies from ten to fifteen days for the first generation to from four to seven days during the heat of summer.

The length of the larval stage varies from two weeks in early spring to about four days in midsummer. The mature larvæ select secluded places in which to transform and are hard to find in the field, but it appears that they usually go down to the basal leaves near the root or into the sheaths higher up the stem. The pupal stage is longer for the long-winged females than for the short, in the former requiring four or five days in early spring, whereas the short-winged form requires only from two to three days at the same season. As the weather becomes warmer they transform more rapidly. The appearance of a number of winged adults early in May marks the maturity of the first generation, but as the length of the period of oviposition exceeds the length of time required for the early stages, there is no distinct line between the generations out of doors after this time. The length of the life cycle is from about twelve to thirty days.

Common name.—Since Professor Comstock's first mention of the injury done by this species of Thrips to June grass and timothy, several economic entomologists have referred to the most conspicuous effects of its work, the dead tops of these grasses, as "Silver top" or "White top." Many have questioned the agency of Thrips in producing this injury and have ascribed it to some other suctorial insect, but the majority of writers are now inclined to credit Thrips with a large part, if not all, of this damage. As they had no means of identifying the little pest, they have usually referred to it as the "Grass Thrips." This name has been very generally used for this species and for no other, so far as we can learn. It therefore appears to be the generally accepted common name.

Economic notes.—Extensive injuries to grass have been reported from the New England States, New York, southern Canada, Ohio, northern Illinois, and Iowa. Without doubt the insect causing this damage infests a larger territory than this, for it is so small that it easily escapes observation, and the damage done by it is often attributed to other agencies. In southern Maine, Professor Fernald reported (253) that by haying time one-fourth of the June grass (*Poa pratensis*) in the fields was dead and worthless. In 1887 it produced great injury around Emmet, Ohio, where 30 per cent of the grass was killed (272). In 1888 and 1889 widespread injury was reported from New York (291) and Ontario (322), where it appeared to work most

upon lawns and meadows. In Massachusetts, especially in dry seasons, its injuries are severe, it having been stated by Prof. W. P. Brooks that this tiny foe does more damage to grasses here than any other single insect.

Genus APTINOTHRIPS Haliday.

Body slender, almost naked. Head longer than wide, extending forward in a blunt projection between the eyes. Eyes small; ocelli wanting. Antennæ eight segmented (six segmented in *A. rufus* var. *connatticornis*). Maxillary palpi three segmented. Prothorax shorter than the head and somewhat broadened posteriorly, without long spines at angles. Legs short; femora plainly thickened; tibiæ very slender at the base, the remainder unusually broad; tarsi equally broad. Wings entirely absent. Hairs at end of abdomen short and very slender.

Males with two spines in middle of ninth segment above.

Species of this genus move slowly and have no power of springing.

I have found only the species *rufus* and its variety, *connatticornis*, belonging to this genus.

APTINOTHRIPS RUFUS (Gmelin).

Plate V, figs. 52–54.

"*Der rothe Blasenfuss*" v. GLEICHEN, das Neueste aus dem Reiche d. Pflanzen, 1764, pl. XVI, figs. 6 and 7.

Thrips rufa GMELIN, Caroli a Linné Systema Nat., 1788, p. 2224.

Thrips rufa NICHOLSON, Journ. Nat. Phil., 179–, pl. VIII, fig. 1.

Thrips (Aptinothrips) rufa HALIDAY, Entom. Mag., 1836, p. 445.

Thrips (Aptinothrips) rufa HALIDAY-WALKER, Homopt. Ins. of Brit. Mus., 1852, p. 1103, pl. v, figs. 5–11.

Aptinothrips rufa LINDEMAN, Bull. Soc. Imp. d. Natur. d. Moscow, 1886, pp. 319–320, fig. 11

Aptinothrips stylifera TRYBOM, Entom. Tidskrift, Årg. 15, Häft. 1–2, 1894, pp. 41–58.

Aptinothrips rufa UZEL, Mon. der Ord. Thysanoptera, 1895, pp. 152–154, pl. II, fig. 17; pl. VI, figs 78, 79.

Aptinothrips rufa TRYBOM, Ofv. Ak. Forh., 1896, p. 613.

Aptinothrips rufa REUTER, Über die Weissährigkeit der Wiesengräser in Finland, 1900. Scattered references, especially pp. 92–120.

Aptinothrips rufa TÜMPEL, Die Geradflügler Mitteleuropas, 1901, p. 290.

Female. Length 1.22 mm. (1.06 to 1.30 mm.); width of mesothorax about 0.18 mm. (0.16 to 0.20 mm.). General color, entire body and legs clear, pale yellow; outer part of antennæ, mouth parts, and tip of abdomen shaded with brown. Body slender and smoothly fusiform.

Head considerably longer than broad, rounded in front; cheeks straight and parallel. Eyes small, black, oval, composed of few facets, situated at anterior angles, protruding very slightly; ocelli always absent. Mouth cone moderately long, not sharply pointed, tipped with brown-black; maxillary palpi three segmented. Antennæ

only one and three-sevenths times as long as the head, approximate at base, composed in the typical form of eight segments of following relative lengths:

1	2	3	4	5	6	7	8
5.5	7.7	7.5	6.1	6.1	11	3	3.3

Segment one is broadly rounded; two has an unusually constricted basal stalk, though it is broader than that of three; three to five bear each one quite slender sense cone on outer angle, and six has one on inner side beyond the middle; spines and sense cones upon all segments pale and inconspicuous. Antennæ concolorous with head at base, but shading outwardly gradually to brown-black at tip.

Prothorax slightly shorter than head and a little broader than long; smooth and without spines. Pterothorax a little broader than prothorax, without spines or traces of wings. Legs short and thick, all nearly equal in length, concolorous with body; tarsi tipped with brown within.

Abdomen unusually long and slender, nearly three and one-half times as long as its greatest diameter, about twice as wide as head, nearly cylindrical to eighth segment, then tapering to a point at tip. No spines upon abdomen except around segments nine and ten; these are quite short and slender and stand out nearly perpendicularly to the surface upon which they are borne. Extreme tip of ten shaded very dark brown.

Redescribed from three specimens.

Males unknown to me. According to Haliday, they are clear yellow, and the saffron-yellow spermaries show through the abdominal walls. The ninth abdominal segment bears two spines in the middle above, not far from the hind edge.

Var. connatticornis Uzel.—This variety agrees very closely with the typical form except that the antennæ have only six segments; the relative lengths of segments are as follows:

1	2	3	4	5	6
5	7	7	6.5	6	16.3

The sixth, seventh, and eighth segments are grown together into one compact sixth segment of an elongated conical form. The abdomen may be a little shorter in proportion and broader.

No males have been taken.

This species appears to be surely *Apt. rufus* Gmelin, but it is larger and differs in some other respects.

Food plants.—Various grasses and in turf.

Habitat.—England (Haliday), Russia (Lindeman), Sweden (Trybom), Bohemia, Germany, Helgoland (Uzel), Finland (Reuter), United States: Amherst, Massachusetts.

Life history unknown.

Genus HELIOTHRIPS Haliday.

Body, especially the head and prothorax, with a deeply recticulated structure. Head broader than long, uneven, somewhat broadened behind, and with a sharp hump between the eyes in front. Cheeks not arched, contracted into saddle-shape in the middle. Eyes prominent but not protruding. Ocelli present. Antennæ eight segmented; second segment of style very much longer than the first and provided with a short, slender hair at the tip. Maxillary palpi sometimes two, sometimes three segmented. Prothorax shorter than the head, without long spines at angles. Legs unarmed. Wings present, not reticulated. Fore wing broad at base, with two longitudinal veins, though the fore vein runs very near to and sometimes fuses with the costa; veins set with slender spines; fore fringe, in some species, very weak and sparse, and when this is the case the costal spines are very strongly developed. Anal spines weak and light.

The characters of this genus have been extended to include these species

SYNOPSIS OF SPECIES.

1 {All tibiæ yellow 2
{Middle and hind tibiæ brown 3

2 {Antennæ nearly three times as long as head .... *femoralis* (p. 172)
{Antennæ only about twice as long as head .... *hæmorrhoidalis* (p. 168)

3 {Antennæ two and one-half times as long as head; segments three and four modioliform. Maxillary palpi three segmented .... *fasciatus* (p. 174)
{Antannæ twice as long as head; segments three and four fusiform. Maxillary palpi two segmented .... *fasciapennis* (p. 171)

HELIOTHRIPS HAEMORRHOIDALIS (Bouché).

Thrips haemorrhoidalis Bouché, Schädl. Garten–Insecten, 1833, p. 42.

Heliothrips adonidum Haliday, Entom. Mag., III, 1836, p. 443.

Heliothrips haemorrhoidalis Burmeister, Handb. d. Entomologie, II, 1838, p. 412.

Heliothrips haemorrhoidalis Burmeister, Genera Insectorum, colored illustration, 1838.

Heliothrips haemorrhoidalis Amyot and Serville, Ins. Hemipt., 1843, p. 641.

Heliothrips haemorrhoidalis Haliday, Walker, Homopt. Ins. Brit. Mus., 1852, p. 1002, pl. vi, fig. 13.

Heliothrips haemorrhoidalis Heeger, Fünfte Fortsetzung. Sitzungsb. Kais. akad. Wiss., Wien, IX, 1852, p. 473, pl. xvii; separate, Wien, Gerold, 1852, VIII, pp. 3–4.

Thrips haemorrhoidalis Bremi, Stett. Ent. Zeit., 1855, pp. 313–315. Reprinted from Abhandl. d. Zurich Gartenbau-Gesell., III, pp. 260–261.

Heliothrips haemorrhoidalis Löw, Verhandl. d. k. k. zool.-bot. Gesellsch., Wien, XVII, 1867, p. 747.

Heliothrips haemorrhoidalis Boisduval, Ent. Hortic., 1867, pp. 233–235, fig. 32.

Heliothrips haemorrhoidalis Packard, 17th Ann. Rept. Mass. Bd. Agr., 1870, p. 263, pl. i, fig. 2; Injurious Ins. new and little known, p. 31.

Thrips adonidum Cook, 3d Ann. Rept. Pom. Soc. Mich., 1873–74, 1874, p. 501.

Heliothrips haemorrhoidalis Packard, Half Hours with Ins., 1881, pp. 118–119, fig. 86.

Heliothrips haemorrhoidalis PERGANDE, Psyche, III, 1882, p. 381.
Heliothrips LEFEVRE, Ent., XV, 1882, p. 240.
Thrips haemorrhoidalis FRIČ, Přirodopis zivočišstva, 1882, p. 113.
Heliothrips haemorrhoidalis LINTNER, 2d Rept. Ins. N. Y., 1885, pp. 29, 31, 38, 56.
Heliothrips haemorrhoidalis ———, Bull. Soc. Ent. Belgique, XXIX, 1885, p. LXX.
Heliothrips adonidum CAMERON, Trans. Nat. Hist. Soc. Glasgow (new ser.), I, 1886, p. 301.
Heliothrips haemorrhoidalis TARGIONI-TOZZETTI, Cronaca entomólogica dell anno, 1887, (1888), p. 5 (7).
Heliothrips haemorrhoidalis JORDAN, Zeit. f. Wissens. Zool., XLVII, 1888, pp. 541–620, pls. XXXVI–XXXVIII.
Heliothrips haemorrhoidalis REUTER, Meddal. af. Soc. Fauna Flora Fenn., XVII, 1891, pp. 164–165.
Heliothrips haemorrhoidalis UZEL, Mon. d. Ord. Thysanopt., 1895, pp. 168–170, pl. VI, figs. 90–92.
Thrips (*Heliothrips*) *haemorrhoidalis* FRANK, Die tierparasitären Krankheiten der Pflanzen, 1896, p. 134.
Heliothrips haemorrhoidalis BUFFA, Riv. Patol. Veget., VII, No. 1–4, pp. 94–108; continued, VII, Nos. 5–8, 1898, pp. 129–135, 136–142.
Heliothrips haemorrhoidalis TÜMPEL, Die Geradflügler Mitteleuropas, 1901, p. 290.

Female.—Length 1.23 mm. (1.12 to 1.39 mm.); width of mesothorax 0.30 mm. (0.25 to 0.35 mm.). Color of head and thorax dark brown; abdomen yellowish brown, fading at tip to brownish yellow. Entire body and legs showing reticulating chitinous thickenings, which are heaviest upon the head, thorax, and anterior sides of abdomen. Head one-fourth wider than long, outline very irregular and rough; cheeks slightly concaved, narrowed abruptly near posterior edge into a short neck; anterior margin strongly arcuate; dorsal surface of head bears a few small spines, the bases of which appear like small air bubbles in the angles of reticulations; frons reticulated. Eyes protruding considerably, strongly pustulated; three ocelli situated on sides of an elevation between the eyes, separated considerably from margins of eyes, pale yellowish, very faintly or not at all margined inwardly by crescentic pigmentation. Mouth cone short, blunt, not reticulated; maxillary palpi three segmented, second segment longest; labial palpi short. Antennæ twice as long as head; relative lengths of segments as follows:

$$\frac{1}{5}\quad\frac{2}{10.3}\quad\frac{3}{17.7}\quad\frac{4}{13}\quad\frac{5}{11}\quad\frac{6}{9.7}\quad\frac{7}{4}\quad\frac{8}{15.5}$$

Second segment thickest, others very slender, especially peduncle and basal half of three; seven is nearly cylindrical, narrow, no thicker than bases of four and five; eight is very slender, tapering slightly, and bearing a single very slender bristle at its tip. Color of one and two light brownish yellow; three, four, and five clear pale yellowish; six abruptly brown, yellowish in basal third; seven and eight gray. Spines upon antennal segments pale and inconspicuous, three especially long ones being situated one each upon the outer angles of three and

four and the inner angle of six: segments three to five faintly annulated.

Prothorax transverse, only about three-fourths as long as head, but nearly twice as wide as long, rounded at the angles; sides slightly concaved, bearing a few small spines, of which only the bright bases are usually visible; reticulation heavy, but interrupted across the middle. Mesothorax one and one-fourth times as wide as the prothorax; reticulation upon mesonotum quite heavy, regular upon anterior half, upon posterior half elongated toward a deep incision in the hind margin of the plate, the longitudinal thickening becoming weaker. Metanotum prominent, triangular, strongly reticulated. Wings very slender, not nearly reaching to tip of abdomen, broadened abruptly at base to more than twice their diameter at middle; only one distinct longitudinal vein, and this sends off a short oblique branch to costal vein. Anterior fringe very short and sparse; posterior quite long and heavy; no prominent spines upon veins. Legs rather short and thick; pale yellowish, except coxæ brownish; first and second pairs about equally long; hind pair a little longer; all legs reticulated.

Abdomen elongate-ovate, pointed at tip; dorsum reticulated; segments two to eight with irregular transverse brown line near front edge of each. Spines upon abdomen mostly small and indistinct; most prominent ones situated upon middle of dorsum of segments two to eight, close to median line; these gradually increase in size posteriorly; anal spines short and weak. Color of abdomen varies from brownish yellow to dark brown; last two segments usually much lighter but less variable in color than rest of abdomen, being regularly brownish yellow tipped with dark brown.

Redescribed from eight females.

Male unknown.

In Germany this species is called "Black Fly."

Food plants.—*Aspidium*, azaleas, *Croton*, dahlias, ferns, Liliaceæ, *Pellea hastata*, *Phlox*, pinks, verbenas, vines, etc.

Habitat.—England (Walker, Cameron), Germany (Bouché, Burmeister, Bremi, Jordan, Bohls), Vienna (Heeger, Löw), Finland (Reuter), United States: District of Columbia, Iowa, Massachusetts, Michigan.

Life history unknown.

In his original description Bouché states that he believes the native land of this species is America. In both countries, however, it has been found almost entirely confined to greenhouses and feeding upon greenhouse plants.

It has been very injurious in some places. Packard calls it "one of our greatest pests in hothouses," and Cook records it as "one of the worst pests around Detroit, at Adrian, and in the southern counties" of Michigan.

HELIOTHRIPS FASCIAPENNIS, new species.

Plate VI, figs. 58–61.

Female.—Length 0.92 mm. (0.90 to 0.94 mm.); width of mesothorax 0.22 mm. (0.22 and 0.23 mm.). General color yellowish brown or dark brown. Head, thorax, and legs distinctly but not deeply reticulated.

Head about one and one-third times as wide as long; form rather rectangular; front margin depressed at insertion of antennæ; cheeks nearly straight. Eyes dark, quite large, prominent but hardly protruding, margins lighter; ocelli present, approximate, pale yellow with dark crescentic margins, well removed from eyes. Maxillary palpi small, two segmented. Antennæ eight segmented, twice as long as head; relative lengths of segments:

$$\frac{1}{4}\quad\frac{2}{8}\quad\frac{3}{11}\quad\frac{4}{10}\quad\frac{5}{9}\quad\frac{6}{5.5}\quad\frac{7}{3.5}\quad\frac{8}{8}$$

Segment one much narrower than two and almost spherical; two is thickest segment and but little longer than thick; three and four fusiform; five clavate; six and seven together of same form as five only inverted; eight very slender and terminated by an equally long hair. Segments one and two, outer half of five, six, seven, and eight brown; three, four, and basal half of five pale yellow. Spines on three, four, and five long, dark, and prominent; color around bases of those on three and four brownish.

Prothorax as long as head and less than twice as wide as long; sides rounded slightly and diverging somewhat posteriorly; without prominent spines at angles; concolorous with head and reticulation of about same depth. Mesothorax somewhat wider than prothorax; anterior edge about straight and angles nearly right angular; membrane yellow; plates brown. Wings long, overreaching the abdomen; fore wing quite slender beyond basal fourth at which point the hind longitudinal vein branches from the fore vein; width in middle about one-fifteenth its length; both veins run close to edges of the wing, the fore one becoming fused with the costa while the hind one remains distinct. Internal veins set with few short spines; costa set with stout spines but without fringe except for slight vestiges along the middle; hind fringe long, dark, and wavy. Wing dark brown crossed with three bands of white as follows: At one-fifth, three-fifths, and four-fifths its length; outer part of scale also white; the brown area at the tip is confined to edge on border around last fifth, the middle here being grayish and in continuation of the last white band. Legs fairly stout but not thickened, weakly reticulated; femora yellowish brown to dark brown; front pair lightest and yellow at tips; fore tibiæ yellow shaded with brown around middle; the other tibiæ brown, yellow at

tips: all tarsi pale yellow with brown shading at bases of bladders; spines weak and light colored: hind coxæ large, approximate, and about twice as long as wide.

Abdomen elongated ovoid, about twice as long as wide; width of segments gradually increasing up to the fourth, then decreasing gradually to tip: greatest width equal to about twice that of head; dark line across segments one to eight irregular, conspicuous only on the lighter specimen: that on segment one curving forward greatly in middle. Surface of abdomen very faintly reticulated, but this is not visible on darker specimen; spines on last two segments short and fine; color yellowish brown to dark brown, lightest along middle.

Described from two females.

Cotype.—Cat. No. 6330, U.S.N.M

Male unknown.

Food plants.—Taken on grass.

Habitat.—Amherst, Massachusetts.

HELIOTHRIPS FEMORALIS Reuter.

Plate V, figs. 55, 56; Plate VI, fig. 57.

Heliothrips femoralis REUTER, Meddel. af. Societas pro Fauna et Flora Fennica, XVII, 1891, p. 166.
Heliothrips cestri PERGANDE, Ins. Life, VII, No. 5, 1895, pp. 390–391.
Heliothrips femoralis UZEL, Mon. d. ord. Thysanoptera, 1895, p. 170.
Heliothrips femoralis BERGROTH, Ann. Soc. Ent. Belgique, XL, 1896, Pt. 2, p. 67.

Female. Length 1.3 mm. (1.12 to 1.5 mm.); width of mesothorax about one-fourth the body length. General color dark brown to yellowish brown, lighter at extremities. Entire surface of body weakly but plainly reticulated.

Head two-thirds as long as broad, widest in front; anterior margin depressed at insertion of antennæ; vertex carinated; bases of antennæ separated by a prominence as high and nearly as wide as the first antennal segment; two transverse wrinkles near back of head more prominent than the others; behind the anterior one of these two the longitudinal parts of the reticulations become very faint; spines upon head scattering and small. Eyes quite large, protruding anteriorly, coarsely granulated; eyes and margins of ocelli bright, dark red by reflected light; ocelli placed on sides and front of a distinct elevation on top of head between eyes. Head light brown with light yellowish longitudinal stripe on each side between eye and ocelli. Maxillary palpi three segmented, short, small; labial palpi minute. Antennæ eight segmented, slender, nearly three times as long as head; relative lengths of segments as follows:

$$\frac{1}{5}\quad\frac{2}{8.8}\quad\frac{3}{16.6}\quad\frac{4}{12.2}\quad\frac{5}{11}\quad\frac{6}{8.6}\quad\frac{7}{4.3}\quad\frac{8}{10.5}$$

Segment one cylindrical, three-fourths as broad as two, which is

barrel-shaped and annulated; remaining segments narrower than these two and more elongated; three and four fusiform; seven and eight nearly cylindrical; eight very slender; one, two, and three nearly concolorous, light yellow with tinge of gray or brown on one and two; four and five light yellow in basal half, shading to light brown on apical half; six, seven, and eight uniformly chocolate brown; segments two to five annulated; spines slender, light colored.

Prothorax transverse, about one-fifth wider than the head, twice as wide as long and shorter than the head; sides rounded; without conspicuously large spines. Mesothorax about one and two-thirds times as wide as the head; anterior angles prominent; mesonotum with deep incision on posterior margin; metanotum with four spines standing in a square near its center. Wings present, long, about one sixteenth as broad as long; fore wings broadened at base, with two longitudinal veins, the second branching from the first not far from the base of the wing. Spines upon veins of fore wing stout, dark colored, and set at uniform distances; costa bears seventeen to twenty, fore vein fourteen to seventeen, hind vein ten to thirteen, scale three to five besides pair at its tip; spines on basal fourth of wing are light colored, smaller and much less conspicuous; anterior fringe on both wings fairly long and stout; posterior fringe long, slender, and dark colored. Wings grayish brown to dark gray, lighter between the longitudinal veins; three nearly white cross bands; one across base before branching of veins, another at three-fourths the length of wing and the third across the tip. Legs: All tibiæ, tarsi, and fore femora yellow; middle and hind femora dark brown, yellow only at ends; spines upon legs small and inconspicuous except ten to twelve on inner side of hind tibiæ.

Abdomen broadly ovoid, conical at tip, twice as wide as head; ovipositor long and slender; tenth segment split open above; segments two to eight with dark cross line near anterior edge. Two or three spines on sides of each segment from two to eight, not conspicuous; anal spines weak. Color of abdomen yellowish brown to dark brown; last two segments much more yellow, but shading to brown at posterior edges.

This species has the power of springing.

No males found.

Food plants.—*Amarillis* sp., *Aralia*, *Arum*, *Cestrum nocturnum*, *Chrysanthemum*, *Crinum*, cucumber, *Dracaena* spp., *Eucharis grandiflora*, *Ficus elastica*, *F. grandiflora*, *Gardenia*, *Gossypium*, *Hydrangea*, *Mina lobata*, moonflower, *Pandanus*, *Phoenix*, *Richardia aethiopica*, tomato, *Vitis*.

Habitat.—Helsingfors, Finland (Reuter), United States: District of Columbia; Amherst, Massachusetts.

Life history unknown.

HELIOTHRIPS FASCIATUS Pergande.

Heliothrips fasciata PERGANDE, Ins. Life, VII, No. 5, 1895, pp. 391–392.

Female. Length 1 mm.; width of mesothorax 0.29 mm. Body faintly reticulated. General color dark brown.

Head about two-thirds as long as wide; cheeks straight; anterior margin depressed at insertion of antennæ; color uniformly brown. Eyes small, black, not protruding; ocelli pale yellowish margined with reddish. Mouth cone moderately long; maxillary palpi slender, three segmented. Antennæ two and one-half times as long as head, eight segmented; bases separated by low elevation; relative lengths of segments:

$$\frac{1}{4.5}\quad\frac{2}{9}\quad\frac{3}{13}\quad\frac{4}{11}\quad\frac{5}{9.25}\quad\frac{6}{6.5}\quad\frac{7}{3.5}\quad\frac{8}{7.5}$$

Segment one rounded, wider than long; two is broadest, constricted abruptly at base, broad at outer end; three and four are of similar shape: modioliform (uniformly constricted at each end with median enlargement regular); outer end of five is quite broadly cut off; six is abruptly constricted at base, outer half tapering gradually; seven nearly cylindrical; eight tapers gradually and bears one very long, slender hair at tip nearly as long as segment itself. One and two uniformly brown, concolorous with head; three and four with light brownish ring around middle of enlargements; remainder pale yellowish, as is also basal half of five; rest of antenna brown; spines around middle of segments three and four and near end of five are long, dark, and conspicuous.

Prothorax fully twice as wide as long, slightly wider at posterior edge than at anterior, without conspicuous spines, colored like head. Mesothorax widest at posterior edge; sides curving gradually inward to anterior edge. Metathorax as wide at front edge as mesothorax is at hind edge, and its sides curve gradually to base of abdomen, so pterothorax appears smoothly rounded. Wings present, extending to tip of abdomen, slender except where broadened at base; two longitudinal veins, the second branching from the first near the broadened base; the fore vein then inclines toward the costal and runs contiguous with it to tip of wing; the hind vein runs close to hind edge, but is distinct. Costal spines twenty in number, very large and stout, much longer than the very weak fringe; fore vein bears four stout spines at basal third and two not far from tip; hind vein bears five moderately long spines; posterior fringes dark, heavy, and wavy. Wings grayish brown, darkest over veins; fore wings at base and a rather broad band at three-fourths their length transparently white, darkest brown around the outer shaded portion. Legs of medium length; femora and tibiæ dark brown except around outer ends of femora, and both

extremities of tibiæ pale yellowish; tarsi also yellowish, brownish around tips; legs bearing quite a number of inconspicuous spines; hind tibiæ alone bearing stout spines at their tips.

Abdomen broadly ovate, pointed at tip, wider than thorax. Color dark brown, somewhat lighter on last two segments. Anal spines weak, especially on last two segments; the few spines on sides of segments two to eight are inconspicuous.

Redescribed from one specimen at U. S. Department of Agriculture, Division of Entomology.

Male not known.

Food plants.—Orange leaf infested with *Aspidiotus aurantii*. (Probably not feeding on scale.)

Habitat.—Yuba County, California.

Life history unknown.

Genus PARTHENOTHRIPS Uzel.

The body, principally the head and prothorax, with deeply reticulated structure. Head broader than long, with a hump in front between the eyes; cheeks swollen, constricted into a short neck at hind edge. Eyes protruding; ocelli present. Antennæ seven segmented, very slender except the first two segments; style one segmented, hair-like, as long as the sixth segment and bearing a slender hair of equal length at the tip. Upon the third to the sixth segments, separated from each other, there are always two sense cones. Maxillary palpi two segmented, the second segment being distinctly longer than the first. Prothorax plainly shorter than the head, uneven, broadened posteriorly, with one long spine upon each hind angle. Legs unarmed. Wings very broad and long, so that they reach beyond the end of the abdomen. The fore wings have the form of a "cake-knife;" their surface is reticulated and there appears to be only one longitudinal vein and a very strongly developed ring vein. The vein arising from the base of the wing bends forward at the first fourth of the length of the wing and unites with the unusually strong ring vein from that point, while the hind vein, branching from the main vein at this point, bends toward the hind edge of the wing and runs parallel to it, but remains distinct. The fore fringe has disappeared and its place is taken by the stout costal spines. The hind vein is set with stout spines at regular intervals. Beyond the first fourth the wing is somewhat narrower than at the basal fourth. The front edge is nearly straight and the hind edge bending forward unites with it to form a sharp point. The last two abdominal segments are distinctly narrowed in the females. The spines at the end of the abdomen are weak and light. The species belonging here have the power of springing.

I have found only the species *dracænæ* of this genus.

PARTHENOTHRIPS DRACÆNÆ (Heeger).

Plate VI, figs. 62–65.

Heliothrips dracænæ HEEGER, Sitzungsb. d. math.-naturw. Classed. kais. Akad. d. Wissensch., Wien, XIV, December, 1854., p. 365. Separata. Beitrage zur Naturgeschichte d. Insecten Osterreichs, pp. 3–7.

Thrips dracænæ REGEL, Bull. phys.-mathem. Acad. Sciences, St. Petersburg, XVI, 1858, pp. 333–336; Melang biolog., II, 6, pp. 628–633.

Heliothrips dracænæ v. FRAUENFELD, Verhandl. d. k. k. zool.-bot. Gesellsch., XVII, Zool. Miscellen, XIII, 1867, pp. 793–801.

Heliothrips dracænæ PERGANDE, Psyche, III, 1882, p. 381.

Parthenothrips dracænæ JORDAN, Zeit. f. Wiss. Zool., XLVII, 1888, pp. 541–620 (Biological part).

Parthenothrips dracænæ REUTER, Meddel af. Soc. Fauna et Flora Fennica, XVII, 1891, p. 166.

Heliothrips dracænæ TRYBOM, Entom. Tidskrift, 15 Årg., Häft 1–2, 1893, pp. 56–58.

Parthenothrips dracænæ UZEL, Mon. d. Ord. Thysanopt., 1895, pp. 171–173, pl. II, figs. 12–14; pl. VI, fig. 93.

Parthenothrips dracænæ TÜMPEL, Die Geradflügler Mitteleuropas, 1901, p. 291.

Female.—Length about 1.15 mm.; width of mesothorax about 0.28 mm. General color dusky yellow, more or less strongly shaded with brown, especially upon the abdomen. Head, thorax, and wings covered with more or less clearly defined reticulating ridges.

Head widest in front through the eyes, four-fifths as wide as length; general shape quadrangular above, though front margin is somewhat elevated in middle; heavily reticulated; cheeks straight, but abruptly constricted at hind edge, neck-like; color quite uniform brownish yellow. Eyes black, very strongly protruding at fore angles; a slight depression surrounds each eye; ocelli small, approximate, with dark red margins contiguous, situated upon a slight elevation between the eyes and well removed from them. Maxillary palpi two segmented, the second segment being longer and more slender than the first. Antennæ seven segmented, very slender beyond second segment, about two and one-half times as long as the head; relative lengths of segments:

1	2	3	4	5	6	7
5	9.7	20.5	17	16.5	14.3	13.5

Segment one nearly spherical, fully as long as broad, narrower than two, which is thickest; three to six subequal in thickness and about one-half the diameter of two, faintly ringed; seven very slender and bearing at its tip a still more slender spine, which may be nearly as long as the segment. Segments one and two slightly more dusky yellow than three to five; five is shaded with brown at its tip; six and seven brown or gray-brown.

Prothorax transverse, fully twice as wide as long and about two-thirds as long as the head, wider behind than in front; sides somewhat

rounded; surface reticulated like head and concolorous with it; one stout spine at each hind angle. Pterothorax on dorsal line only two-thirds as long as wide, one and one-fourth times as wide as prothorax; metathorax nearly as wide as mesothorax; color of pterothorax somewhat more yellow than head and prothorax; mesonotal plate deeply incised in middle behind; reticulations converging to anterior end of this incision. Wings very long and about one-tenth as broad, overreaching the abdomen considerably; form and venation unique; fore wings somewhat longer and about one and one-half times as broad as the hind wings; their front edge runs straight clear to the tip; the hind edge runs nearly parallel to it till near the end, where it curves forward to join the fore edge at the tip; the entire wing is bounded by one very heavy ring vein. There appears to be only one longitudinal vein; this at about basal fourth of wing curves forward to the costal vein, which it joins;[a] then it curves backward and runs parallel with and quite close to the hind edge till it joins the ring vein before the tip. The costa bears no fringe, but is set with numerous stout spines as is also the longitudinal vein; hind edge bears a double fringe of long hairs; surface of fore wing shows faint reticulation. There are three rather faint brown spots on fore edge, the darkest being where the fore vein joins the costa, and one longer spot on hind edge; spines standing in these spots are much darker than the others. Legs concolorous with body, finely reticulated; hind coxæ approximate; fore femora brownish yellow, the others brown, yellowish at extremities; tibiæ and tarsi concolorous with second segment of antennæ; tarsi tipped with dark brown; spines very weak and light colored.

Abdomen distinctly wider than thorax and broadly joined to it; about twice as long as broad, ovoid, pointed at tip; general color brown or yellowish brown; last three segments yellow; sometimes the sides of each segment are much more yellow than its brown central area; anterior edge of segment one is curved forward very abruptly in the middle forming a rounded apex to the dorsal plate; prominent dark stripe on anterior edges of three to seven; anal spines weak and light.

Redescribed from five females taken in Amherst, Massachusetts, on *Kentia* and *Ficus*. I have no male, but Heeger says:

Male.—The abdomen in males is distinctly more slender than in females; is yellow-brown, thinly chitinized; about twice as long as the meso and metathorax together; almost cylindrical, with tapering anal extremity; naked, set with some long bristles only at the hinder edge of the last three abdominal segments.

Food plants.—Dracæna, *Ficus elastica*, *Kentia balmorina*.

[a] I believe that the fore vein coincides with the costal from the spot where they join, the cross vein being more apparent than real, and that the vein which runs parallel with and close to the hind edge is really the hind vein.

Habitat. Vienna (Heeger, v. Frauenfeld), Finland (Reuter), St. Petersburg (Regel), Germany (Jordan, Bohls), Bohemia (Uzel), United States: Washington, District of Columbia; Amherst, Massachusetts.

The early stages are described as follows:

Egg. The eggs are nearly membranous, greenish white, elongate-ovate, $\frac{1}{15}'''$ long, half as broad.

Larva. Larvæ are milky white, nearly cylindrical; only the last three abdominal segments taper gradually to a blunt point; they are about $1\frac{1}{4}'''$ long, $\frac{1}{4}$ as thick. The head is inverted conical, a little more slender but noticeably longer than the breadth of the abdomen; mouth parts are thin, horny, yellowish, pointed, snout-like. Eyes are on the sides of the head, circular, not raised; relatively large and clear red. The antennæ are thread-like, white with gray points, five segmented, somewhat longer than the head; first three segments small, cup-shaped, of equal size; fourth, spindle-shaped, about as long as first three together; fifth is gray, conical, very pointed, somewhat longer than the fourth.

The thorax is somewhat longer than the antennæ, swollen, flat beneath; prothorax is rounded-triangular, somewhat shorter than the pterothorax, the segments of which are grown together, and are elongated-rectangular and rounded. The legs are close together, with very large coxæ; nearly as long as the antennæ; middle pair noticeably shortest, hind pair longest; femora shorter and thicker than tibiæ, which are cylindrical; tarsi very short, indistinctly two segmented.

Abdomen spindle-shaped, nearly as broad and somewhat more than twice as long as the entire thorax; the nine segments are hardly perceptibly marked, equally long and set at sides with single, knobbed hairs.

Nymph or pupa. The nymphs in the last days before their transformation are whitish, fusiform; their eyes are raised, round, and red; antennæ indistinctly eight segmented, laid back over the head near one another; wing sheaths lying at the sides of the abdomen, slender, bottle-shaped, reaching to the fore edge of the sixth segment and set with many transparent, white hairs, as is also the spindle-shaped abdomen; the hind edge of the next to the last and the end of the last segment set with single, knobbed hairs.

Genus THRIPS Linnæus.

Ocelli present. Antennæ seven segmented (style one segmented). Maxillary palpi three segmented. Prothorax regularly somewhat longer than the head; two long spines always present upon its posterior angles. Fore legs usually unarmed. Wings usually present, moderately broad, with fore fringe developed and veins set with short spines.

The species belonging here have the power of springing.

Although this is the largest genus of the order, I have here found but two species which I can place in it. These two may be easily distinguished by their colors.

Head brown, thorax reddish brown, abdomen yellow or gray-brown..*perplexus* (p. 184).
Color uniformly light yellowish varying to brownish yellow..........*tabaci* (p. 179).

THRIPS TABACI Lindeman.

ONION THRIPS.

Plate VII, figs. 69–71.

? Limothrips tritici PACKARD, 2d Ann. Rept. Ins. of Mass., 1872, pp. 5–8, 2 figs.; 19th Ann. Rept. Secy. Mass. Bd. Agr. for 1871, pp. 333–336, 2 figs.; reprinted in 9th Ann. Rept. U. S. Geol. Geog. Surv. Territories for 1875, pp. 742–744, pl. LXVII, figs. 3–5.

Thrips on onion plants, SHIPLEY, Bull. 10, Miscell. Information Roy. Gardens, 1887, p. 18.

Thrips tabaci LINDEMAN, Die schädlichsten Insekten des Tabak in Bessarabien, 1888, p. 15, 61–75.

Thrips sp. THAXTER, Ann. Rept. Conn. Exp. Sta. for 1889, 1889, p. 180.

Thrips sp. RILEY-HOWARD, Insect Life, III, 1891, p. 301.

Thrips tabaci RITZEMA BOS, Tierische Schädlinge und Nützlinge, 1891, pp. 577, 578.

Thrips tabaci TARGIONI-TOZZETTI, Animali ed Insetti del Tobacco in Erbal del Tobacco Secco, 1891, pp. 222–224.

Thrips sp. LINTNER, Count. Gent., LVII, Oct. 27, 1892, p. 809; Abstract in 9th Rept. Ins. N. Y., p. 445.

Limothrips sp. BAKER, Amer. Florist, VII, 1892, p. 168, fig.

Thrips striata ? GILLETTE, Ann. Rept. Col. Exp. Sta. for 1892, 1892, p. 36.

Thrips on onions, WEBSTER, Ins. Life, V, 1892, p. 127.

Thrips striatus GILLETTE, Bull. 24, Col. Exp. Sta., 1893, pp. 13–15, figs. 11, 12.

Thrips striatus RILEY-HOWARD, Ins. Life, VI, 1893, pp. 4–5, 343.

Thrips striatus ? GILLETTE, 5th Ann. Rept. Col. Agr. Exp. Sta. for 1892, 1893, p. 36; 6th Ann. Rept. Col. Agr. Exp. Sta. for 1893, p. 55.

Onion Thrips, SMITH, Ann. Rept. N. J. Agr. Col. Exp. Sta. for 1893, 1894, p. 441.

Limothrips tritici WEBSTER, Ins. Life, VII, 1894, p. 206.

Thrips allii SIRRINE and LOWE, Bull. 83, N. S., N. Y. Agr. Exp. Sta., 1894, pp. 680–683, pl. II.

Thrips allii WEBSTER, Ohio Farmer, Aug. 2, 1894, p. 97; Aug. 23, 1894, p. 157; Nov. 7, 1894, p. 373.

Thrips allii SIRRINE and LOWE, 13th Ann. Rept. N. Y. Exp. Sta. for 1894, 1895, pp. 758–760, pl.

Thrips allii OSBORN-MALLY, Bull. 27, Iowa Agr. Exp. Sta., 1895, pp. 139–142.

Thrips tabaci PERGANDE, Ins. Life, VII, 1895, pp. 392–395.

Limothrips tritici WEBSTER, Bull. 58, Ohio Agr. Exp. Sta., 1895, pp. xxxiii–xxxiv, fig. 3; also in Ins. Life, VII, 1895, p. 206.

Thrips communis UZEL, Mon. d. Ord. Thysanoptera, 1895, pp. 176–179, pl. VI, fig. 100.

Thrips tabaci UZEL, Mon. d. Ord. Thysanoptera, 1895, p. 447.

Thrips tabaci SLINGERLAND, Rural New Yorker, LV, 1896, p. 561.

Thrips tabaci FRANK, Die tierparasitären Krankheiten der Pflanzen, 1896, p. 134.

? *Thrips sp.* near *tabaci* DAVIS, Special Bull. 2, Mich. Agr. Exp. Sta., 1896, p. 13.

? Thrips on cabbages, SMITH, Economic Ent., 1896, p. 102.

? Thrips on cucumber, BRITTON, 20th Rept. Conn. Exp. Sta. for 1896, 1897.

Thrips tabaci SIRRINE, 15th Ann. Rept. N. Y. St. Exp. Sta. for 1896, 1897, pp. 612–613.

Onion Thrips, SIRRINE, Bull. 115, N. Y. Exp. Sta., 1897, p. 70.

Onion Thrips, SLINGERLAND, Rural New Yorker, May 8, 1897, p. 309.

Thrips tabaci LINTNER, 51st Ann. Rept. N. Y. St. Mus. Nat. Hist., 1898, p. 363; Separata, 13th Rept. Inj. Ins. N. Y., 1898, p. 333.

Thrips striatus GILLETTE, Bull. 47, Col. Exp. Sta., 1898, p. 44.

Thrips tabaci QUAINTANCE, Bull. 46, Fla. Agr. Exp. Sta., 1898, pp. 103–114, figs. 10–12.

Thrips tabaci HOWARD, Yearbook, U. S. Dept. Agr. for 1898, 1899, pp. 142, 143, fig. 27.

Thrips tabaci PETTIT, Bull. 175, Mich. Exp. Sta., 1899, pp. 343–345, figs. 1, 2.

Thrips tabaci QUAINTANCE, Bull. 20, N. S., U. S. Dept. Agr., p. 59. Remedies, various authors, 1899, p. 60.

Thrips tabaci WEBSTER-MALLY, Bull. 20, N. S., U. S. Dept. Agr., 1899, pp. 67–70.

Thrips in Greenhouses, FERNALD-HINDS, Bull. 67, Mass. Exp. Sta., 1900, pp. 9–12.

Thrips communis TÜMPEL, Die Geradflügler Mitteleuropas, 1901, p. 293.

Thrips tabaci GARMAN, Bull. 91, Kentucky Exp. Sta., 1901, pp. 42–45.

Thrips tabaci WEBSTER, Journ. Columbus Hort. Soc., XVI, 1901, No. 3, 7 pp., 4 figs.

Thrips tabaci HINDS, Proc. 17th Ann. Conv. Soc. Amer. Florists, 1901, pp. 90–92.

Female.—Length about 1.1 mm.; width about one-fourth the length. Color quite uniformly light yellowish varying to brownish yellow.

Head one-fifth wider than long; cheeks slightly arched behind the eyes; frons slightly arcuate between them; occiput indistinctly transversely striated; hairs upon the head few and minute; eyes not protruding, coarsely granulated, very dark red by reflected light, black by transmitted light, sparsely pilose; ocelli subapproximate, standing well back to the line of the hinder edge of the eyes but posterior ocelli not contiguous with margins of eyes; color light yellow, margined inwardly with light brown crescents. Maxillary palpi three segmented; first and third segments equally long, second shorter. Antennæ seven segmented; relative lengths of segments as follows:

1	2	3	4	5	6	7
4.4	8.7	11.1	10	8.6	10.6	4

Segment one short and globose; two barrel-shaped; three to five pedunculate, elongated ovoid; five joined by moderately broad surface to base of six which tapers somewhat from its middle to its apical end; seven tapering slightly, blunt at apex. Segment one lightest in color, clear light yellow; two, six, and seven uniformly light grayish brown; three light brownish yellow; four and five colored like three at their bases but apices nearly as dark as six.

Prothorax as long as head, one-half wider than long; pronotum, indistinctly transversely striated and sparsely clothed with small spines; each hind angle bears a pair of very stout, conspicuous spines,

and between these pairs, along the hind edge of pronotum, stands a row of three smaller spines on each side. Metathorax one-third wider than prothorax; metanotal plate bears a few small spines. Wings about one-fourteenth as broad as long, slightly colored with light yellow; costal fringe of fore wings composed of short, stout bristles intermixed with a row of shorter spines. Fore longitudinal vein bears from ten to twelve spines arranged in three groups, as follows: Two groups upon the basal half of vein, the first of three or four spines, the second group of three, and beyond the middle of the wing four to six spines scattered at considerable distances along the vein to its tip; when only four are present in last group they stand at nearly equal distances apart; hind vein bears from fourteen to seventeen spines. Occasionally one or two cross veins may be seen between the fore vein and the costal at about one and two-thirds its length, but usually they are not present; hind vein arises from fore vein at about the middle of second group of spines. Hairs composing posterior fringes on both wings are long, slender, wavy, and light colored. Legs concolorous with body or somewhat lighter, quite long and slender; second segments of tarsi much longer than first; spines on inner side of hind tibiæ weak, except the pair at its extremity; legs sparcely clothed with fine hairs.

Abdomen as wide, or slightly wider, than the mesothorax, about twice as long as wide; each dorsal plate of segments two to eight marked near its anterior edge with a narrow, transverse line of dark chestnut-brown color, widest at its middle and tapering gradually toward the sides, disappearing at the upper edge of the groups of three to five short spines which stand upon these segments just above the pleural plates. Posterior edge of ninth segment bears a circlet of eight long, stout spines, most prominent dorsally; terminal segment bears six spines which are nearly as long as the preceding; besides these long spines both of these segments bear a few finer spines.

Redescribed from many specimens.

Male.—"Head and abdomen yellowish white; thorax yellow. The first two antennal segments white, the third at the end very weakly, the fourth and fifth more strongly shaded with gray; the sixth is gray, at the base or even to the middle white; the seventh segment entirely gray. Wings present."—Uzel.

Food plants. Apple, aster (cultivated), blanket flower, blue grass, cabbage, candytuft, catnip, cauliflower, celery, chickweed, cinquefoil, clover, coneflower, crab-grass, cucumber, dandelion, *Erechthites*, *Erigeron canadensis*, four-o'clock, garden leek, goldenrod, heal-all, honeysuckle, Jamestown weed, jimson, kale, melons, mignonette, mullein, nasturtium, onion, parsley, pink, plum, pumpkin, *Rubus* several species, shepherd's purse, *Specillaria*, squash, stonecrop, sweet clover, timothy, tobacco, tomato, turnip, wheat.

Habitat. Russia (Lindeman), England (Shipley), Italy (Targioni-Tozzetti), Bohemia, Helgoland (Uzel), Bermuda, United States: Massachusetts, Connecticut, New York, Long Island, Pennsylvania, New Jersey, District of Columbia, Virginia, Florida, Kentucky, Ohio, Indiana, Illinois, Iowa, Michigan, southern Canada, Colorado, California.

The early stages are described by Quaintance[a] as follows:

Egg.—Length 0.26 mm.; width 0.12 mm.; in shape the egg is elliptical and curved. Fresh eggs are clear white. In eggs with advanced embryos, the reddish eyes are distinctly visible.

Larva, first stage.—(About one-half hour after hatching). Length, 0.38 mm.; width of thorax, 0.14 mm.; somewhat fusiform in shape; gradually tapering caudad from fourth or fifth abdominal segment; body, legs, and antennæ clear white; eyes reddish. Head in dorsal aspect about as broad as long; the eyes are situated at the cephalic lateral margins; no ocelli. In cephalic aspect the head is seen to be considerably produced ventrad and caudad; suboval in outline. The four jointed antennæ are borne upon the vertex, and are approximate at base. Basal joint short, cylindrical, about half the length of second; second segment subpyriform, slightly longer than wide; third subspherical, about as long as second; fourth joint as long as the proximal three together, club-shaped, thickest near the basal third, tapering distally to a point. Joints three and four ringed; in the distal part of four these are much more pronounced, dividing it into what might be taken for short, indistinct segments. The antennæ bear setæ, which are much more numerous on fourth joint. Legs stout; coxa and trochanter short; femur about as long as tibia and tarsus together. The tarsus appears to be composed of but one joint, which terminates distally in two diverging claw-like processes; the bladder-like expansion on tip of tarsus does not seem to be present in this stage. Abdomen composed of ten segments; on the dorsum are four longitudinal acute setæ, and a row on each lateral margin. On the tenth segment these setæ are quite large, being from two to four times longer than the others.

Mature larva (*second stage*).—Length 0.94 mm.; width of mesothorax 0.22 mm. Body elongate; abdomen tapering caudad from about fifth segment. Head slightly longer than wide. Color greenish yellow, varying to greenish white. Legs and antennæ lighter; eyes reddish brown; ocelli wanting. Setæ practically as in stage 1. Antennæ four-jointed;[b] basal joint short, cylindrical; second, subcylindrical, about twice as long as first. Third joint a fourth longer

[a] Quaintance, Bull. 46, Fla. Agr. Exp. Sta.

[b] "Lindeman regards the antennæ as six jointed, but to me joint four has not appeared to allow of being considered as made up of three joints, although there are four more or less well-defined parts, as determined by the rings, which, if considered as joints, would make seven in all, instead of six."

than second; subpyriform, united to second by narrow "neck," rather closely ringed. Fourth, about as long as proximal three together, club-shaped, ringed as in stage 1. Antennæ bearing setæ much more numerous on fourth joint. Tarsi without the pronounced claw-like structures of the first stage. In other respects essentially as in preceding stage.

Nymph (about two days old).—Length about 0.7 mm.; width of mesothorax about 0.15 mm.; color yellowish, varying to almost colorless; eyes reddish. Pupa-skin somewhat separated from the body proper, being particularly noticeable in the caudal end of the abdomen, wing-pads, legs, and antennæ. In these two latter the joints are very obscure, the pupa-skin covering them as a sheath. The wing-pads reach to about the eighth abdominal segment. There are numerous setæ on the body, antennæ, legs, and wing-pads. On the abdomen they have practically the same position as in the adult larva. The dorsal setæ of the last segment in the nymphs are very stout, almost hook-like, curving cephalad.

Life history.—Dr. Lindeman's conclusions, quoted by Dr. Lintner, are so different from those which have been reached by workers upon the same species in this country that we are led to suspect that he has confused the early stages of very different species.

In Massachusetts, using specimens found infesting a cucumber house in January and February, I have found that the egg stage varies from four to seven days. Pupation takes place in seven or eight days and lasts for nearly a week, when the adults emerge and after a few days lay their eggs. The whole life cycle in a greenhouse thus occupies from three to four weeks.

In Florida Quaintance found that the egg stage lasts in summer from three and a half to four days; the larval stage from seven to nine days, during which time the larva molted twice; the nymph stage four days, the total life cycle thus requiring about sixteen days. There appeared to be no distinct broods at any season.

In Ohio Professor Webster has found that this species hibernates in larval, pupal, and adult stages, the first predominating, being found in matted grass or refuse tops left in the onion fields, and that they safely passed through winters when the temperature fell to −23 to −25 degrees F.

Economic considerations.—Dr. A. S. Packard, in 1872, was the first to record the ravages of the "Onion Thrips," which he called *Limothrips tritici* Fitch, believing it to be identical with the "Wheat Thrips." While Dr. Packard's description is unidentifiable, it is sufficient to show that the insect was not *Thrips tritici* Fitch, nor did it belong to the genus *Limothrips.* Furthermore, Packard states that the antenna consists of eight segments, which would separate it from *Thrips tabaci*, which has only seven. Still the injury recorded is so like that which is known to have been committed by *Thrips tabaci* at

various times that I have included a reference to it under this species, though its correctness is questionable.

Dr. Packard found that this insect has been observed attacking onions for fifteen years previously, but the damage in 1872 was unusually severe in Essex County, Massachusetts, amounting that year to at least one-tenth of the crop, and having a money value in that one county of at least $10,000.

In 1889, Dr. Thaxter found the Onion Thrips generally distributed and very injurious to onions in Connecticut, the injury produced being known as "White Blast."

The next report of very serious injury was made by Prof. C. P. Gillette from Colorado, where for several seasons it had been noticed as very abundant and doing considerable harm. It has also been found a serious pest all through the Middle States and in several of the Atlantic coast States as well as on the Pacific coast. This shows its very wide general distribution, and since its attacks seem to be most severe upon onions and cabbages—two important garden crops—it must be considered as, perhaps, the most injurious species of the order.

THRIPS PERPLEXUS (Beach).

Plate VI, figs. 66–68.

Sericothrips? perplexa BEACH, Proc. Iowa Acad. Sciences, 1895, III, (1896), pp. 216–218.

Female. Length 0.935 mm. (0.80 to 1.0 mm.); width of mesothorax 0.197 mm. (0.18 to 0.21 mm.). General color: head brown and thorax reddish orange-brown, very much darker than the pale yellow or gray-brown abdomen; body slender.

Head very large, somewhat pentagonal, approximately as long as broad or but slightly shorter, almost as large as prothorax, within which it is slightly withdrawn; cheeks nearly straight and parallel; anterior margin broadly elevated; without special prominences between bases of antennæ; occiput transversely wrinkled; without conspicuous spines. Eyes black, not protruding, together occupying about one-half the width of the head, margins lighter colored; ocelli conspicuous, large and well separated, placed far forward, all three being in front of the middle of the eyes, reddish yellow with maroon inward margins; ocellar bristles moderately long. Maxillary palpi three segmented. Antennæ fully twice as long as head, subapproximate; relative lengths of segments:

$$\frac{1}{5.5}\quad\frac{2}{7.6}\quad\frac{3}{10.4}\quad\frac{4}{12}\quad\frac{5}{8.8}\quad\frac{6}{13}\quad\frac{7}{6.1}$$

Segment one broader than two which is intermediate in thickness between one and three; three and four thickest at about their middle then tapering gradually to the ends; seven bluntly conical. Spines

long and slender, but not very conspicuous; those on three to five nearer the middle than usual. Color of one, two, five, six, and seven brown like head; three and four pale yellowish or gray; four shaded slightly with brown, increasing toward tip; basal constriction of five yellowish.

Prothorax not longer and but very slightly wider than the head, nearly square, without stout spines upon fore angles but with two long spines at each hind angle. Mesothorax about one and one-half times as wide as head, slightly wider than metathorax; greatest width at hind edge; color reddish or orange-brown. Wings reaching usually beyond the tip of abdomen, about one-seventeenth as broad as long; fore wing with two longitudinal veins; the origin of the hind vein indistinct; neither vein heavy; costa set with about twenty quite long spines besides the fringe hairs; fore vein bears ten to twelve rather weak spines and the hind vein about thirteen similar spines. Legs rather short; fore femora slightly thickened; yellow to gray-brown, bases of bladders dark brown; spines small except row of eight or nine on inner side of hind tibiæ.

Abdomen nearly cylindrical and long, two and two-thirds times as long as wide; but very slightly wider than mesothorax; last three segments very short and tapering very abruptly to the acute apex. Color pale yellowish or grayish brown, very much lighter than thorax and head; ninth and tenth segments shading to brown-black; intersegmental membranes pale yellowish or gray. Segments not overlapping; receptaculum seminis placed far back beneath eighth dorsal plate, very conspicuous, bright orange-red; ovipositor indistinct, vestigial; tenth segment split open above and sides nearly meeting beneath; anal spines long, slender, not very dark.

Redescribed from seven females taken on grass at Amherst, Massachusetts.

Male unknown.

Food plants.—*Cyperus* sp., corn and grass (Iowa), *Dactylis glomerata*, *Panicum sanguinale*, and various other grasses (Massachusetts).

Habitat.—Ames, Iowa; Amherst, Massachusetts.

These specimens have been compared with Miss Beach's types and are identical. The vestigial condition of the ovipositor, however, misled her into thinking her specimens all males, whereas they are really all females.

This species is exceptional among the Terebrantia in lacking a functional ovipositor, but it is surely vestigial in this case. The eggs are very large, while the ovipositor is disproportionately short and weak, and it seems that it must be impossible for this species to deposit its eggs in the plant tissue. In this respect they thus show a divergence toward the Tubulifera, which lay their eggs wholly exter-

nally. It also seems probable that the so-called "rod" of the Tubuliferan female is but the vestige of a former ovipositor. The wing venation also indicates that the Æolothripidæ come nearest the primitive form and that Phlœothripidæ have diverged farthest from the type, with the Thripidæ somewhere in between. This species is therefore of considerable interest as possibly being one of the guide-posts to the phyllogeny of the order Thysanoptera.

CHARACTERS OF TUBULIFERA (PLŒOTHRIPIDÆ).

The members of this suborder agree so closely in general characters that they have all been included in the single family Phlœothripidæ. They are, as a rule, considerably larger and more powerfully formed than the Terebrantia, some of them being the giants of the order.

In the insects belonging to this suborder the head is always as long as broad, and may be two or three times as long. In most of those species which have comparatively short heads the front is smoothly rounded, but in those having very much elongated heads the vertex is considerably elevated, in some cases even forming a very prominent conical projection of the vertex beyond the bases of the antennæ. The eyes vary widely in size and number of facets. Ocelli are generally present. The cheeks are usually nearly straight and parallel, and in some species set with more or less numerous spine-bearing warts. Nearly every species has a pair of well-developed spines standing immediately behind the eyes, and therefore called post-ocular spines. The antennæ are invariably eight segmented in the adult stage and the sense cones on the intermediate segments are always simple. The mouth cone varies in form, being in some species short and blunt, and none of the external parts are acute at the tips; in others the labrum is abruptly constricted beyond the middle, its end forming a sharp spine-like process, which reaches beyond the broadly rounded labium; in still others the entire mouth cone, labium and all, is elongated and tapers to a quite slender tip, which, however, is not spine-like. These different forms of mouth cone have been thought to possess a generic value in classification, but my studies thus far have led me to the conclusion that too high a value has been placed upon this single character. The maxillary palpi have always two segments, of which the basal is very short, and the labial palpi are also two segmented, though frequently they are short and indistinct.

The prothorax has, in most cases, a trapezoidal form, and this is especially noticeable in those species in which the fore femora are much enlarged. The regularity of the outline of this trapezoid is, however, more apparent than real, as will be seen by reference to Plates VIII, IX, and X. The projecting fore coxæ fill in the hind angles so smoothly that in many cases careful focusing is necessary to show that the outline is not entirely that of the prothorax alone. The pro-

notum usually bears around its outer portion a number of conspicuous, long spines. The fore femora are frequently greatly enlarged, and when this is the case there will be found upon the fore tarsus a more or less stout tooth or hook. In most species the femora and tarsal teeth are larger in the males than in the females. The pterothorax is very compact and nearly rectangular in outline. The wings, which are usually present, are all very similar in form, venation, etc. They are either quite slender throughout or somewhat constricted near the middle, and are rounded at the tips. They have almost no veins, there being no ring or cross veins, and only one partially developed median vein in each wing. Along the margins of each wing there is borne a long, slender fringe, which is single except near the outer end of the hind margin of the fore wing, where it is double for a short distance. The membrane of each wing lacks microscopic spines such as are found upon the wings of Terebrantia. When brought to rest the wings are laid back closely upon the middle of the abdomen, so that they overlap in their second halves. They are here held in place, and the long, slender fringes confined by the rows of inwardly curved spines which stand upon each side of the second to seventh segments. In some species the wings are reduced to short, rounded pads, while in others even these are wanting.

The abdomen is very similar in both sexes, except that in the male it is usually more slender, especially through the sixth, seventh, and eighth segments. The female has no ovipositor. The sexual opening is between the ninth and tenth segments in both males and females. The last segment is a simple tube in both sexes and at its base, beneath, are found the distinctive sexual characters. The female is distinguished by a short, strongly chitinized rod upon the ninth segment near the base of the tube which is regular and entire. The male is distinguished by a semicircular notch in the base of the underside of the tube, providing an opening for the protrusion of the copulatory apparatus which is wholly retracted into the ninth segment. In many species the abdomen is somewhat flattened dorso-ventrally so that a cross section is elliptical in outline.

Tubuliferans live usually in secluded places, as between the parts of composite flowers, under the bark of trees, on the underside of foliage, in galls, moss, turf, fungi, etc. Their movements are very deliberate and they never run or spring.

SYNOPSIS OF PHLŒOTHRIPIDÆ.

1	Body slender, head more than one and one-half times as long as wide	8
	Body more or less thickened, head less than one and one-half times as long as wide	2
2	Breadth of abdomen of female nearly or quite one-half its length	3
	Breadth of abdomen of female not nearly equal to one-half its length	4
3	Head broadly rounded in front, cheeks without warts	*Trichothrips* (p. 191)
	Head narrowed in front	*Eurythrips* (p. 202)

4	Wings always present, usually inhabiting flowers	5
	Wings usually reduced, usually inhabiting bark or turf	7
5	Cheeks without spine-bearing warts	*Anthothrips* (p. 188)
	Cheeks with spine-bearing warts	6
6	Fore femora with teeth at tip within, intermediate antennal segments unusually long and slender	*Acanthothrips* (p. 198)
	Fore femora without teeth in female and usually in male, intermediate antennal segments not elongated	*Phlœothrips* (p. 195)
7	Head very large, rounded in front	*Cephalothrips* (p. 194)
	Head small, narrowed in front	*Malacothrips* (p. 200)
8	Head more than twice as long as wide	*Idolothrips* (p. 206)
	Head less than twice as long as wide	*Cryptothrips* (p. 205)

Genus ANTHOTHRIPS Uzel.

Head but little longer than wide, rounded in front; cheeks nearly parallel, without warts. Antennæ nearly twice as long as the head. Ocelli and wings always present in both sexes. Wings narrowed in the middle. Mouth cone not longer than the breadth at its base; labrum narrowed toward tip but not sharply pointed. Fore tarsi armed with a tiny tooth which is somewhat larger in males than in females. Males without a scale at base of tube.

The two species belonging here may be easily separated by the presence or absence of spines upon the head. In *A. niger* (p. 188) the cheeks are smooth, without spines, and there are no post-ocular spines, while in *A. verbasci* (p. 189) the cheeks bear small spines not standing on warts and the post-ocular spines are well developed.

ANTHOTHRIPS NIGER (Osborn).

Plate VII, figs. 72–75.

Phlœothrips nigra Osborn, Canad. Entom., XV, 1883, p. 154; Rept. U. S. Dept. Agr. for 1887, (1888), pp. 163, 164; Ins. Life, I, 1888, pp. 137–142; Ins. Life, V, 1892, pp. 112–113.—Davis, Bull. 116, Mich. Agr. Exp. Sta., 1894, pp. 62, 63.

Anthothrips nigra Uzel, Mon. d. Ord. Thysanoptera, 1895, p. 242.

Female.—Length 1.5 mm. (1.1 to 1.8 mm.); width of mesothorax 0.34 mm. (0.3 to 0.4 mm.). General color more or less dark reddish brown.

Head approximately as long as broad, longer than prothorax, smoothly rounded in front; cheeks straight, parallel, and without warts. Eyes small, finely faceted; ocelli quite large and well separated, posterior ocelli almost contiguous with margins of eyes; no post-ocular bristles. Mouth cone shorter than its breadth at base and blunt at tip. Antennæ subapproximate, as long as width of mesothorax; segments quite short and stout; fourth thickest and most rounded; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
6	10.3	12.3	12.9	11.5	10.7	10.6	7.4

Color nearly uniform brown; three and base of four yellowish brown; spines short and weak; sense cones short and blunt.

Prothorax one-half as long as breadth to outer angles of coxæ; front and hind edges nearly parallel, gently curved; one short spine at each posterior angle and one nearly halfway between this and middle of hind edge. Mesothorax somewhat wider than prothorax but usually less than twice as wide as the head; sides of pterothorax nearly straight, shorter than its breadth. Legs short and moderately stout; fore femora but slightly thickened; fore tarsi armed with a tiny tooth near tip within; middle and hind tibiæ with one prominent spine externally at tip. Legs brown; middle and hind tarsi slightly yellowish, sometimes brown; fore tarsi and tip of tibiæ yellow. Wings always present, narrower in middle than at ends, shaded with brown only at base, where fore wing bears three erect spines. Wings and fringes nearly equal; fringes single, except on hind border of fore wing near tip, where for seven or eight hairs they are double.

Abdomen about twice as broad as head, averaging about two and one-half times as long as wide; segments overlapping somewhat; sides nearly parallel to middle, then tapering gradually to base of tube. Tube about four-fifths as long as head, only slightly tapering; sides straight; terminal spines shorter than tube. All spines on abdomen short, weak, and not conspicuous.

Redescribed from seven specimens.

Male unknown.

Food plants. *Achillea millefolium*, ox-eye daisy, red clover, white clover, various grasses.

Habitat.—Iowa, Michigan, Massachusetts.

ANTHOTHRIPS VERBASCI (Osborn).

Plate VII, figs. 76–78.

——— Osborn, Ins. Life, I, 1888, pp. 137–142.
Phlœothrips verbasci Osborn, Proc. Iowa Acad. Sc., III, 1896, p. 228.

Female.—Length 1.8 mm. (1.42 to 2.12 mm.); width of mesothorax 0.38 mm. (0.32 to 0.44 mm.). General color dark brown.

Head but slightly, if any, longer than wide; cheeks nearly straight and parallel, set with few minute spines; post-ocular bristles prominent; hind margin of head not covered by front margin of prothorax. Eyes finely and closely faceted, rounded, not protruding; ocelli widely separated, posterior ones contiguous with the light margins of eyes; front ocellus placed at extreme vertex. Mouth cone about as long as it is broad at base, pointed. Antennæ approximate, almost twice as long as head; relative lengths of segments:

$$\frac{1}{9}\quad\frac{2}{12}\quad\frac{3}{15}\quad\frac{4}{15}\quad\frac{5}{15}\quad\frac{6}{14}\quad\frac{7}{12.6}\quad\frac{8}{10.6}$$

Segment three clavate; four fusiform; five and six becoming more slender and less fusiform; seven cylindrical; eight sharply conical. Segment one and base of two dark brown; tip of two, seven, and eight yellowish brown; intermediate segments pale yellow. Spines pale and weak; sense cones short and blunt.

Prothorax short, only about three-fourths as long as head; fore and hind margins nearly parallel and curving backward; one stout spine at each angle, one in middle of sides, and one on each side between those at the angle and the median line on both fore and hind margins; hind angles appear to entirely cover the fore coxæ as a rule; each fore coxa bears one stout spine. All these stout spines are blunt but not knobbed. Sides of pterothorax full and smooth; fore angles oblique; color of thorax uniform dark brown or yellowish brown, more or less irregularly mottled with dark red. Wings present, narrowed in middle, transparent except at base, where the fore wing bears three long spines upon the remnant of the single median vein. Fringes long, single, except near end of hind fringe of fore wing where it is double for ten or twelve hairs. Legs moderately long and slender; fore femora only slightly thickened; fore tarsus one segmented and armed with a tiny tooth. All femora and middle and hind tibiæ dark brown; middle and hind tarsi slightly yellowish or grayish brown; fore tibiæ and tarsi bright yellow like middle of antennæ; fore tibiæ shaded a little with brown toward their bases outside. One long slender spine near base of each fore femur below; each fore coxa with one long spine.

Abdomen broadly joined to metathorax and but slightly wider, widest at base but less than twice as wide as head; segments more or less imbricate, tapering gradually to tube. Tube about four-fifths as long as head, tapering slightly, not swollen at base, bearing a circlet of spines at tip which are shorter than the tube. All spines on abdominal segments slender and rather faint; color of abdomen quite uniform yellowish brown to dark brown. In the lightest colored specimens the irregular dark mottlings show up most prominently.

Redescribed from eight females.

Male. The male agrees quite closely with the foregoing description; it is usually somewhat smaller throughout; relative lengths of antennal segments are as follows:

$$\frac{1}{8.5}\quad\frac{2}{11.5}\quad\frac{3}{13.5}\quad\frac{4}{14.5}\quad\frac{5}{14}\quad\frac{6}{12.8}\quad\frac{7}{12}\quad\frac{8}{10}$$

Fore tarsi are armed with a medium-sized tooth, which is larger than that in the female. Of the four spines standing near the hind edge of the ninth segment, the outer pair is very short, stout, and acute; the abdomen seems to be somewhat more slender than in female.

Described from four males.

Food plant.—Mullein.

Habitat.—Ames, Iowa; Amherst, Massachusetts.

Genus TRICHOTHRIPS Uzel.

Head about as broad as long, broadly rounded in front. Eyes small. Ocelli present in both these species, but often wanting. Mouth cone not longer than its breadth at base; labrum pointed at tip. Fore femora somewhat enlarged and tarsi armed with a tooth. Wings usually wanting, but present in both these species, slender throughout. Abdomen very broad and heavy; tube very slender in proportion to width of abdomen; no scale at base of tube in the male.

The two species which I have placed in this genus may be distinguished by the following characters:

Tube fully as long as the head .... *beachi* (p. 192)
Tube two-thirds as long as the head .... *ambitus* (p. 191)

TRICHOTHRIPS AMBITUS, new species.

Plate VIII, figs. 81, 82.

Female. Length 2 mm.; width of mesothorax 0.45 mm. General color brownish yellow shading to brown or reddish brown.

Head slightly longer than wide, widest just behind the eyes, rounded in front; cheeks straight and converging posteriorly; at hind edge only six-sevenths the diameter at widest part; frons slightly elevated between bases of antennæ; post-ocular bristles present; a few scattering small spines upon head not raised upon warts; surface faintly reticulated. Anterior half of head light brown flecked with reddish, posterior half fading to yellow at the neck. Eyes small, finely granulated, compact, not pilose, purplish by transmitted light, reddish orange by reflected light; ocelli present, subapproximate, pale yellow margined inwardly with reddish brown crescents. Mouth cone reaching nearly to posterior edge of prosternum; maxillary palpi two segmented; labial palpi short and thick; labium broad and rounded; maxillæ converging abruptly below the palpi and short. Antennæ one and three-fourths times as long as the head, eight segmented, though the joint between seven and eight is very indistinct; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
12	18	28	26	21	20	15	8

Segment one truncate, conical; two constricted toward base into a broad stalk, cut off squarely at end; three to seven slenderly stalked at bases; three to six clavate; seven cylindrical-ovate, very closely united by full width of end to eight which is conical. Color of one pale brownish yellow; two and three clear yellow; four yellow at base

shading to light brown at end: remaining segments dark brown. Sense cones on segments three to six very long and slender; transparent spines upon each segment also long and slender.

Prothorax three fourths as long as head and three fifths as long as wide; fore coxæ project considerably beyond posterior angles. One medium length spine on each side of middle and near anterior edge, one near each anterior angle, one at middle of each side and one longer one at each posterior angle. Mesothorax equal in width to prothorax and concolorous with it; mesonotum bears one long spine close to base of each fore wing. Metathorax equal in width to mesothorax, narrowed but very slightly posteriorly, pale yellow in middle, shaded on sides, splashed with red. Each fore coxa bears a single long spine on outer side; fore femora somewhat enlarged; each femur bears a single long, erect spine on the outer side near its extremity; tarsi short and thick, fore pair armed with a stout tooth. Femora gray-brown, fore pair yellowish brown; fore tibiæ and tarsi pale yellow; middle and hind tibiæ and tarsi almost white. Wings reaching to tip of abdomen; both pairs equal in size, edges parallel, heavily fringed; fore wings bearing a costal group of three long slender spines between the fringe and base of wing. Color of wings clear, transparent, except a slightly clouded band across fore wings at about one-third their length.

Abdomen broad and heavy; last three segments tapering abruptly; at sixth segment one and one-sixth times as broad as thorax. Tube two-thirds as long as head and at middle one-seventh as broad as the fourth abdominal segment; terminal spines about as long as tube. A stout bristle projects anteriorly from each side angle of first segment; each following segment, except tube, bears on each side one spine; these are short upon first segment and increase in length and size posteriorly. Color brownish yellow in middle, shaded with dark reddish brown on sides; tube bright brownish yellow tipped abruptly with gray-brown.

Described from one female.

Male unknown.

Food plant.—Grass.

Habitat.—Amherst, Massachusetts.

TRICHOTHRIPS BEACHI, new species.

Plate VII, fig. 79; Plate VIII, fig. 80.

Female.—Length 1.84 mm. (abdominal segments one-third telescoped); width of mesothorax 0.48 mm. General color yellow-brown.

Head as broad as long, rounded in front; cheeks slightly converging behind the middle, set with scattered, small, stout spines borne upon small warts; post-ocular bristles quite long and acute. Eyes small, finely faceted, rounded; ocelli large, distant, posterior two almost

contiguous with light yellowish margins around eyes, color reddish yellow. Antennæ more than twice as long as the head; length and breadth of segments increase gradually from base to middle, then decrease to tip of antenna; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
9	15	22	22	19	17	14.5	13

Color dark brown; bases of three to five yellowish; spines of medium length, but not very conspicuous; sense cones about one-third of the length of the segment bearing them.

Prothorax about five-sixths as long as head, and nearly twice as broad as long, broadly rounded at hind edge; spines upon fore edge much smaller and weaker than the mid-lateral and those on hind edge; all these spines are acute. Mesothorax about one and one-half times as wide as prothorax, uniting closely and evenly with metathorax so that sides of pterothorax are nearly straight. Wings present, long and powerful; fringes long, double for from nine to eleven hairs in hind fringe of fore wing near tip. Legs of medium size and length; fore femora a little thickened and tarsi armed with a very tiny tooth; middle legs much the smallest. All femora chestnut brown; tibiæ at base brown, fading to yellowish at tips; fore tibiæ lightest; tarsi yellow. Fore coxæ project a little beyond sides of prothorax and each bears one long spine; each femur bears one long slender spine on under side near base; three or four long slender spines stand around tips of middle and hind tibiæ.

Abdomen large and heavy, somewhat broader than thorax, slightly more than twice as broad as head; segments overlapping about one-third; sides nearly parallel up to eighth segment, then tapering very abruptly. Tube slender in middle, about one-eighth the breadth of the abdomen, fully as long as the head, tapering but slightly; terminal circlet of spines shorter than tube; spines on abdomen light colored.

Color of whole body generally yellowish brown, lightest along middle of back of thorax and abdomen; abdomen darkest where segments overlap; thorax and abdomen show some irregular dark red hypodermal pigmentation. All spines acute.

Described from one female taken under quince bark in early spring, together with many bright-red larvæ around it.

Male unknown.

Food plant.—Taken under quince bark.

Habitat.—Amherst, Massachusetts.

I take pleasure in naming this species for Miss Alice M. Beach in recognition of her work upon the Thripidæ of Iowa.

Genus CEPHALOTHRIPS Uzel.

Head considerably longer than its breadth or the length of the prothorax, broadly rounded in front and larger than in most species in proportion to the other segments. Eyes small; ocelli present. Antennæ about one and one-half times the length of the head. Mouth cone shorter than its breadth at base; labrum not narrowed in the middle and ending in a blunt point. Fore femora slightly thickened and tarsi with a tiny tooth. Wings usually reduced or wanting entirely. Male without a scale at base of the tube.

I place here only one species, *yuccæ*.

CEPHALOTHRIPS YUCCÆ, new species.

Plate VIII, figs. 83, 84.

Female.—Length 1.48 mm. (1.40 to 1.56 mm.); width of mesothorax 0.29 mm. (0.28 to 0.30 mm.). General color yellowish brown, irregularly mottled with dark-red hypodermal pigmentation.

Head broad and large, about one and two-fifths times as long as wide; cheeks slightly arched and smoothly joined to eyes, converging slightly toward neck; front smoothly rounded; post-ocular bristles present, but rather small and not prominent; cheeks smooth. Eyes small, each being less than one-fourth the breadth of the head through them, triangular above and surface even with that of head, very dark red in color; ocelli small, situated far forward, quite widely separated, with very dark red inner margins. Mouth cone short and rather blunt. Antennæ nearly one and one-half times as long as head, considerably separated at bases with but slight elevation between them; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
6.5	11.6	12.5	12.5	11.8	11.3	11.2	8.25

Segments three to five subequal in breadth and similar in shape. Antennæ yellow, segments one and two shaded with brownish. Sense cones quite long and slender; spines shorter and light colored, so inconspicuous.

Prothorax two-thirds as long as head and across outer angles of coxæ about one and two-fifths times as wide as head; sides of thorax really considerably indented above fore coxæ. Anterior marginal and mid-lateral spines wanting; those at angles present, but weak and inconspicuous. Pterothorax as broad as prothorax through coxæ, equal to about one-fifth the length of the body; its sides straight and parallel; about four-fifths as broad as abdomen. Wings usually reduced to mere pads, but when occasionally present they are of moderate length, though not very powerful. (Winged specimens have the

pterothorax nearly as wide as the abdomen.) Legs rather short and thick; fore coxæ project somewhat beyond thorax; fore femora slightly thickened and the tarsi armed with a tiny tooth; tibia of each leg slightly shorter than its femur; all tarsi short and thick. All femora and middle and hind tibiæ brown; all tarsi and fore tibiæ, except at base outside, pale yellow; a prominent brown spot at tip of tarsi within.

Abdomen about three-fifths the length of the body; about one and one-fourth times as broad as the mesothorax; nearly cylindrical to seventh segment, then sides curve smoothly to base of tube. Tube less than one-half as long as head and at middle only about one ninth the breadth at middle of abdomen. Spines on abdomen of moderate length, slender, acute, light colored, and not prominent. The abdomen is darkest at sides and tip; on each side of segments two to eight, slightly outside the line of wing-confining spines, there is a rounded or elliptical clear yellow spot. The body lacks any striking coloration.

Described from ten wingless and two winged females.

Cotype.—Cat. No. 6331, U.S.N.M.

Male. The males are about five-sixths as large as females. Their antennæ are about one and two-fifths times as long as the head; there appears to be less difference in the length of antennal segments than in female; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
6	10	11	10.25	10	9.75	9.75	7.4

Abdomen about one and one-fifth times as broad as mesothorax; tube about one-half as long as head and at middle about two-fifteenths as broad as middle of abdomen.

Described from nine males, all short winged. All of my males were taken in September, and it may be that winged specimens occur earlier in the season.

Cotype.—Cat. No. 6331, U.S.N.M.

Food plants.—*Yucca filamentosa*, goldenrod.

Habitat. Amherst, Massachusetts; Washington, District of Columbia.

Genus PHLŒOTHRIPS Haliday.

Head somewhat longer than wide; cheeks with small warts, each bearing a tiny spine. Intermediate antennal segments not particularly elongated; the whole antenna less than twice as long as head. Mouth cone as long or longer than its breadth at base and narrowed; labrum sharply pointed at tip. Fore femur enlarged and tarsus armed with a tooth. Wings not narrowed in middle, present in both sexes. No scale at base of tube in male.

I place two species in this genus. They may be separated by the following characters:

All femora dark brown; tibiæ and tarsi bright yellow .... *uzeli* (p. 196).
Legs gray brown; tarsi somewhat lighter; fore tibiæ yellowish... *pergandei* (p. 197).

The female of the species *uzeli* comes within the definition of the genus *Phlœothrips*, but the male of this species has the teeth at the tip of the fore femora, which is the principal character upon which Uzel has separated his genus *Acanthothrips*. This species, therefore, appears to unite the characters of these two genera, and as more emphasis is placed upon the description of the female than upon that of the male, I have preferred to include this species in the established genus *Phlœothrips* rather than to erect a new genus for it.

PHLŒOTHRIPS UZELI, new species.

Plate VIII, figs. 87–90; Plate IX, figs. 91, 92.

Female.—Length 1.76 mm. (1.72 to 1.86 mm.); width of mesothorax 0.39 mm. (0.38 to 0.40 mm.). General color dark brown with yellow tibiæ and tarsi.

Head about one and one-fourth times as long as wide, rounded in front; cheeks nearly straight and parallel, set with several short, stout spines borne upon small warts; post ocular bristles quite long and knobbed. Eyes moderately large, rounded, finely faceted; ocelli prominent, distant, reddish yellow, posterior ones contiguous with light borders of eyes. Mouth cone long and pointed, reaching to posterior edge of prosternum. Antennæ about one and three-fourths times as long as the head, slightly more than twice as long as width of head; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
9.7	12.3	18	18.3	16	14.3	13.3	8.5

Segments one and two dark brown; three brownish yellow, lightest at base; four to six light brown, pale yellow at base; seven and eight light brown; spines long but not very dark colored; sense cones over one-third the length of the segment bearing them.

Prothorax two-thirds as long as head, and to angles of coxæ twice as wide as long; usual anterior marginal, posterior marginal and midlateral spines present, knobbed. Mesothorax slightly wider than prothorax; sides of pterothorax straight and converging a little to base of abdomen. Wings long and powerful. Legs of medium length and quite stout; fore femora somewhat thickened and the tarsi armed with a small tooth; middle of outer surface of each fore tibia and femur supports one long slender spine near the base on under side. All femora dark brown; all tibiæ and tarsi bright yellow, the middle and hind ones being slightly shaded with brown.

Abdomen large and stout, about four times as long as head, as wide as mesothorax; sides nearly parallel to seventh segment, from there tapering roundly to base of tube; segments overlapping about one-third. Tube four-fifths as long as head; sides straight and converging slightly; breadth in middle one-seventh that in middle of abdomen; terminal circlet of hairs about the length of the tube, very slender. Spines on sides of abdomen blunt; abdomen quite uniformly yellowish brown (dark brown where segments overlap).

Described from three females.

Cotype.—Cat. No. 6332, U.S.N.M.

Male. Males about six-sevenths as large as females. Cheeks slightly fuller; relative lengths of antennal segments as follows:

1	2	3	4	5	6	7	8
8	11	15.6	15.9	13.9	12.4	11	7.9

Fore femora larger than in female and terminating in two teeth at tip within; fore tibiæ have each a small tooth near base within; teeth on fore tarsi large. (The teeth upon femora and tibiæ are not found at all in the female of this species.) Tube at middle about one-sixth the width at middle of abdomen; abdomen tapering slightly.

Described from five males.

Cotype.—Cat. No. 6332, U.S.N.M.

Food plants.—Taken on various grasses, clover, and *Ulmus montana* var. *pendula*.

Habitat.—Amherst, Massachusetts.

This species is named for Dr. Henry Uzel, of Königgrätz, Bohemia, whose Monograph of the Order Thysanoptera is by far the best work that has been published upon this order.

PHLŒOTHRIPS PERGANDEI, new species.

Plate VIII, figs. 85, 86.

Female.—Length 1.68 mm. (abdominal segments overlapping for about one-fourth their length); width of mesothorax 0.42 mm. General color yellowish brown, with considerable irregular red hypodermal pigmentation.

Head about one-sixth longer than wide, widest close behind the eyes, rounded in front; cheeks slightly curved and bulging behind eyes, converging slightly posteriorly, set with a number of short, stout spines borne upon quite prominent warts; post-ocular bristles long and knobbed. Eyes about medium in size, slightly elongated, finely faceted; ocelli quite large, distinct, subapproximate, reddish yellow with dark red crescentic margins, situated well forward upon vertex, which is slightly elevated. Mouth cone quite long, reaching to back of prosternum; labrum sharply pointed and overreaching the

labium. Antennæ twice as long as width of head: relative lengths of segments as follows:

1	2	3	4	5	6	7	8
10	14	22	21	17	14	13	8.5

Color of antennæ brown with bases of three, four, five, and six decreasing in area and intensity of yellowishness; sense cones about one-third the length of segment three; spines quite long, dark, and conspicuous.

Prothorax only five-sevenths as long as head, and to outer angles of fore coxæ slightly more than twice as wide as long; usual prothoracic spines present, quite long and knobbed. Mesothorax as wide as width across fore coxæ, closely joined with prothorax; pterothorax very compact, sides converging slightly to base of abdomen. Wings long and powerful. Legs quite strong; fore femora much thickened, over one-half as broad as head; fore tarsi armed with a small tooth. Color of legs uniformly gray-brown; tarsi somewhat lighter; fore tibiæ yellowish, shaded with brown at bases and on top.

Abdomen less than twice as broad as head, equal in width to mesothorax, nearly cylindrical to eighth segment; eighth and ninth tapering abruptly to base of tube. Tube only two-thirds as long as head; sides straight, tapering somewhat; breadth in middle about one-eighth that of middle of abdomen; terminal hairs a little longer than tube. All large spines on body, except those on hind edge of nine and at tip of tube are short and knobbed; those on nine and tube are acute. Color of abdomen pale brownish yellow, lightest in middle; blood-red pigmented tissue confined mostly to sides of abdomen in this specimen.

Described from one female.

Male unknown.

Food plant.—Taken on grass.

Habitat.—Amherst, Massachusetts.

I name this species for Mr. Theodore Pergande, by whom several of our native species have been described.

Genus ACANTHOTHRIPS Uzel.

Head somewhat longer than wide; cheeks with spine-bearing warts. Antennæ very nearly twice as long as head; intermediate segments elongated and bearing very long sense cones. Mouth cone considerably longer than its breadth at base and quite slender. Fore femora enlarged in both sexes and with one or two teeth at tip within; tarsus armed with a stout tooth (Uzel says the tooth is weaker in the male than in the female). Wings present in both sexes. No scale at base of tube in the male.

I have placed the single species *magnafemoralis* in this genus, though I do not know the female. The characters of the fore femora and antennæ are sufficient to separate it generically from *Phlæothrips*.

ACANTHOTHRIPS MAGNAFEMORALIS, new species.

Plate IX, figs. 93, 94.

Male. Length 2.16 mm.; width of mesothorax 0.42 mm. General color yellowish brown with antennæ, legs, and eighth and ninth abdominal segments banded with nearly transparent or yellowish white.

Head nearly one and one-fourth times as long as wide; cheeks bulging abruptly and greatly behind the eyes, then converging to the neck, which is as wide as the diameter through the eyes; cheeks, especially anterior parts, set with short spines borne upon very prominent tubercles; front between eyes very narrow, carinated. Eyes large, finely faceted, reniform above, inner edges parallel; ocelli small, approximate, and placed between the middle of the eyes. Proboscis long, slender, pointed; labrum sharply pointed. Antennæ scarcely twice as long as the head and very slender; relative lengths of segments as follows:

$$\frac{1}{10}\quad\frac{2}{12}\quad\frac{3}{29}\quad\frac{4}{26}\quad\frac{5}{23}\quad\frac{6}{15}\quad\frac{7}{15}\quad\frac{8}{9}$$

Segments one to five subequal in thickness; three to five similar in shape, elongated, urn-shaped; eight sharply conical. Segments one, two, seven, and eight quite uniformly dark brown; bases of three to five and tips of three and four pale yellowish, nearly white on three; six entirely pale yellow, with slight brownish tinge on outer half; antennæ appear annulated with pale yellow and dark brown. Spines and sense cones long, slender, and light colored; the cones on three to five fully one-third the length of segment three and on six about three-fifths its length.

Prothorax about two-thirds as long as head; width to outer angles of coxæ nearly twice its length; transverse margin nearly straight; the usual stout spines on thorax and abdomen, except those at tip of tube, are extremely short and blunt. Mesothorax slightly wider than the abdomen; middle of pterothorax concaved slightly. Wings long and rather slender. Legs moderately long; fore femora extremely thick and large, almost as wide as length of fore tibiæ; fore femora armed with a stout tooth at the tip within; fore tibiæ bent outward at base; fore tarsi one segmented, armed with a very stout tooth; middle and hind tibiæ rather short and swollen in the middle, their tibiæ quite slender and their tarsi two segmented. Fore femora yellowish brown; fore tibiæ and tarsi pale yellowish, tibiæ alone shaded with brown on middle of outside; middle and hind femora almost transparent white at base, outer half shaded with brown and having a

roundish, light yellowish spot on side of dark area; middle and hind tibiæ pale yellowish at base and tip, banded with dark brown around the middle, these tarsi pale yellow, brown at tips; surface of all legs rough, being thickly set with minute warts, each bearing a small spine.

Abdomen about two-thirds the length of the body, tapering gradually from second segment to tip; width at second segment but slightly less than that of mesothorax. Tube slightly more than three-fourths as long as head; diameter at middle of tube about one-sixth that at middle of abdomen. Sides of metathorax and surface of abdomen, up to about the seventh or eighth segment, peculiarly roughened with closely set small warts, many of which bear small spines. The tube is nearly cylindrical, without a scale at its base, and at the tip bears a circlet of eight extremely long, slender, acute hairs, which are nearly three times as long as tube. The basal third of tube is very pale yellowish white; the outer two-thirds is abruptly brown-black; segments eight and nine pale yellow; three to seven appear irregularly striped with pale yellow and dark brown; dorsal stripe pale yellow and about the width of the wings; a subdorsal row of dark-brown, semicircular spots, which stand one in the middle on each side of these segments with the straight side toward the dorsal line, gives the appearance of a subdorsal stripe; then follows on each side an irregular, pale yellow stripe, and the middle of the sides of the segments is shaded with brown. Spines on sides of abdominal segments and the back of eighth and ninth are extremely short and blunt.

Described from one specimen.

Female unknown.

Food plant.—?

Habitat.—Miami, Florida.

MALACOTHRIPS, new genus.

Head plainly longer than wide and narrowed in front. Cheeks full and with spine-bearing warts; vertex elevated. Antennæ nearly twice as long as head. Mouth cone as long as its breadth at base, reaching the hind edge of the prosternum; labrum quite sharply pointed at tip. Prothorax two-thirds as long as head. Pterothorax somewhat constricted in middle. Fore tarsi with a tiny tooth. Wings usually reduced to pads. Abdomen large and full in the female. A closely lying scale at base of tube in the male.

This genus contains only one species, *zonatus*.

(*μαλακος*, soft; *θριψ*.)

MALACOTHRIPS ZONATUS, new species.

Plate IX, figs. 95–98.

Female.—Length 1.62 mm. (1.50 to 1.68 mm.); width of pterothorax 0.30 mm. (0.27 to 0.34 mm.). General color pale bright yellow on

thorax and segments one, three, four, and five of the abdomen; head and other abdominal segments brown. Body apparently weakly chitinized.

Head nearly one and one-third times as long as wide, narrowed in front; cheeks moderately full and set with a few small spines borne upon small warts; head appears constricted close behind the eyes, and slightly so at neck; post-ocular bristles well developed; front of head between eyes developed into a prominence bearing the antennæ; vertex produced into a sort of hump, which, however, does not overreach the insertion of the antennæ. Eyes small, finely faceted, dark purplish red, surrounded by pale yellow margins; ocelli present, subapproximate, borne well forward upon the hump, the front ocellus being upon its vertex; pigmentation around ocelli bright red. Mouth cone moderately long and slender; labrum abruptly constricted and sharply pointed at tip. Antennæ approximate at base, almost twice as long as head; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
9.8	13.5	18.4	16.5	15.8	13.9	12.4	11.4

Basal segments large, truncate-conical, placed divergently; three clavate; from three to eight the segments become gradually more narrow. Antennæ nearly uniformly brown, except three, which is yellowish brown; spines and sense cones quite long, but slender and light colored, so inconspicuous.

Prothorax about two-thirds as long as head and across outer angles of coxæ about twice as wide as long. All the usual prominent prothoracic spines well developed, but light colored; hind margin not sharply defined. Pterothorax in middle slightly narrower than width across fore coxæ; mesothorax short, slightly narrower than metathorax and slightly brownish yellow in color. Wings reduced to very small pads, each fore pad bearing three quite long, blunt spines. Legs of medium length and middle and hind pairs quite slender; fore coxæ projecting considerably beyond thorax; fore femora slightly thickened and tarsi armed with a small tooth. All legs pale yellow or pale brownish yellow with prominent brown spot within tip of tarsus.

Abdomen about one and two-fifths times as broad as metathorax, quite stout to eighth segment, then sides converging to base of tube. Tube about three-fourths as long as head and one-third as wide at middle as long; sides straight, tapering slightly; terminal spines about as long as tube; spines on sides of abdomen pale, but quite prominent in reduced light. Segment one is concolorous with metathorax; three to five are clear, bright yellow; two, six, seven, and eight are yellowish brown, darkest on sides; nine and tube are darkest brown.

Described from four females.

Cotype.—Cat. No. 6333, U.S.N.M.

Male. Length about five-sixths that of female; head and prothorax nearly as long as in female; relative lengths of antennal segments as follows:

1	2	3	4	5	6	7	8
10	11	16	14	13.8	11.8	10.5	9.5

Abdomen only about four-fifths as long or as broad as in female and tapering more uniformly from base to tip.

Described from two specimens.

Cotype.—Cat. No. 6333, U.S.N.M.

Food plant.—Taken in turf.

Habitat.—Amherst, Massachusetts.

EURYTHRIPS, new genus.

Head as long or somewhat longer than wide, narrowed in front. Eyes small and vertex between them elevated. Antennæ fully twice as long as the head and thicker than in most species. Prothorax about two-thirds the length of the head. Fore tarsi with a small tooth, which is larger in the male than in the female. Wings usually reduced to short pads. Abdomen unusually large and heavy in proportion to the rest of the body. Males with a closely lying scale at the base of the tube.

The species *ampliventralis* is the type of this genus.

(ευρυς, broad; θριψ.)

The two species belonging to this genus may be separated by the breadth of the abdomen, which in *ampliventralis* (p. 202) is about one and two-thirds times as wide as the pterothorax, while in *osborni* (p. 203) it is only about one and one-fourth times as wide as the pterothorax.

EURYTHRIPS AMPLIVENTRALIS, new species.

Plate IX, figs. 99–101.

Female.—Length 1.08 mm. (1 to 1.20 mm.); width at middle of pterothorax 0.24 mm. (0.22 to 0.25 mm.). General color of head and legs clear yellow to brownish yellow; body shading posteriorly to dark brown beyond middle of abdomen.

Head slightly longer than wide, slightly narrowed in front, broadest at neck; cheeks diverging gradually behind the eyes; vertex drawn out into a hump between and in front of the eyes; post-ocular bristles quite long; head clear, brownish yellow with some red hypodermal pigment on vertex. Eyes extremely small and composed of but very few large facets, slightly protruding, oval in outline, black; ocelli wanting. Mouth cone short and blunt; labrum not constricted beyond middle. Antennæ approximate, large, and heavy, fully twice the length of the head, with peculiar, semicircular, shelf-like support visible on under side at base; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
9.2	10.4	14.8	13.5	12.8	11.9	9.5	6.4

Segment one is broadest, cylindrical, and following segments decrease gradually in diameter; three is clavate, four to seven each barrel-shaped, with a short stalk. Antennal segments shade gradually from concolorous with head at base to very dark brown at tip; spines and sense cones very long, slender, and quite prominent.

Prothorax quite variable in length, but averaging slightly more than two-thirds as long as head; width also unusually variable, but averaging twice its length and equal to width of pterothorax. Anterior marginal spines wanting; others present, moderately long, blunt, but not knobbed. Pterothorax very small, rather shorter than prothorax and usually slightly narrower. Wings reduced to mere pads. Fore and middle legs rather short and thick, but hind legs quite long and slender; fore femora but slightly thickened and tarsi armed with a tiny tooth. Legs concolorous with head; femora shaded somewhat with brown, but without hypodermal pigment.

Abdomen exceedingly large and heavy, about one and two-thirds times as broad as pterothorax; posterior half rounding up to base of tube. Tube fully two-thirds as long as head and almost one-half as broad at middle as it is long; sides straight and tapering evenly; terminal hairs slightly shorter than tube; spines on sides of abdomen quite long and prominent.

Prothorax concolorous with head, but much more suffused with irregular, bright red hypodermal pigmentation. (Seen by reflected light on white background.) Pterothorax and base of abdomen more shaded with brown, and the latter becoming darker toward tip, where it is dark brown or almost black. Pterothorax, and sides of abdomen especially, thickly marked with bright red hypodermal pigment.

Described from five females.

Cotype.—Cat. No. 6334, U.S.N.M.

Male unknown.

Food plant.—Taken in turf in fall.

Habitat.—Amherst, Massachusetts.

EURYTHRIPS OSBORNI, new species.

Plate X, figs. 102, 103.

Female. Length 1.12 mm. (1 to 1.22 mm.); width of mesothorax 0.27 mm. (0.25 to 0.30 mm.). General color light yellowish brown to dark brown; head and legs yellow.

Head approximately as long as wide, narrowed in front; the antennæ standing upon a triangular projection between the eyes; head enlarged quite abruptly behind the eyes; cheeks not converging posteriorly. Eyes very small, depressed, finely faceted, almost oval in outline,

black; ocelli present, small, frequently more or less hidden by irregular dark-red local pigmentation, placed well forward upon an elevation between the eyes; postocular bristles quite long. Mouth cone short and blunt; labrum not constricted abruptly. Antennæ very large and long, fully two and one-half times as long as head, with a semicircular, shelf-like support below bases; bases approximate; elevation between them extending half the height of first segments; relative lengths of segments as follows:

$$\frac{1}{8.3} \quad \frac{2}{10.5} \quad \frac{3}{15.3} \quad \frac{4}{14.2} \quad \frac{5}{14.2} \quad \frac{6}{11.9} \quad \frac{7}{10.} \quad \frac{8}{9.9}$$

Segment one large and cylindrical; two cup-shaped; three very slender at base, clavate; four to seven also slender at bases, decreasing gradually in diameter and length of stalk; eight enlarging to one-third its length and then tapering to a sharp point. Color shading gradually from concolorous with head at base to dark brown at tip. Spines and sense cones long, slender, and quite conspicuous. Head clear, pale yellow to brownish yellow.

Prothorax and pterothorax (in short-winged specimens) along dorsal line, each approximately as long as head; width of prothorax across coxæ nearly twice its length, its sides indented considerably above them. Anterior marginal spines wanting; others present as usual (at angles, mid-lateral and posterior marginal) long, slender, and blunt. Mesothorax approximately as broad as prothorax; in long-winged specimens about one-fourth longer than in short-winged, and also slightly fuller. Legs short and moderately stout; fore femora but slightly enlarged and tarsi armed with a small tooth; one long, erect, knobbed spine upon the back of each femur. Legs yellow; femora shaded with brown; in darker specimens femora more strongly shaded.

Abdomen large and heavy; fore angles abrupt; about one-half as wide as long; nearly cylindrical to seventh segment, then sides curve roundly to base of tube. Tube as long or slightly longer than head, about one-third as broad in middle as long, more slender in outer than in basal half; terminal spines only about two-thirds as long as tube; those on sides of abdomen quite long and prominent, knobbed.

Thorax and abdomen uniform in color, abruptly darker than head and legs, ranging from yellow-brown to dark brown, with considerable dark red, irregular, hypodermal pigmentation.

Described from ten females, eight long and two short winged.

Cotype.—Cat. No. 6335, U.S.N.M.

Male. Males about six-sevenths as large as females. Relative lengths of antennal segments as follows:

$$\frac{1}{8} \quad \frac{2}{10} \quad \frac{3}{12.6} \quad \frac{4}{12} \quad \frac{5}{12} \quad \frac{6}{10.2} \quad \frac{7}{8.6} \quad \frac{8}{8.6}$$

The prothorax is a little wider than the mesothorax. Fore femora

considerably enlarged and tooth upon tarsus quite stout. Abdomen more slender than in females and tapering more gradually.

Described from five males, all short winged.

Cotype.—Cat. No. 6335, U.S.N.M.

Food plants.—Grasses.

Habitat.—Amherst, Massachusetts.

This species is named for Prof. Herbert Osborn, who has for many years shown considerable interest in the study of these tiny insects.

Genus CRYPTOTHRIPS Uzel.

Head cylindrical, fully one and one-half times as long as wide. Eyes large and prominent. Vertex strongly elevated and bearing the anterior ocellus at its extremity. Mouth cone about as long as its breadth at base and reaching about two-thirds across the prosternum; labrum blunt. Prothorax about as long as width of head. Legs slender; fore femora but slightly enlarged; fore tarsi unarmed. Wings present, slightly narrowed in middle. Male with a scale at base of tube.

I find only one species belonging to this genus, *aspersus.*

CRYPTOTHRIPS ASPERSUS, new species.

Plate X, figs. 104–106.

Female.—Length 1.68 mm. (1.45 to 2 mm.); width of mesothorax 0.32 mm. (0.28 to 0.36 mm.). General color yellowish brown to brown-black; body and legs considerably marked with irregular, dark-purplish, hypodermal pigmentation.

Head cylindrical, one and one-half times as long as wide, about as wide as length of prothorax; cheeks almost straight and nearly parallel, set with a few minute, slender spines; postocular bristles short; surface of head finely cross-striated. Eyes quite large, finely faceted, very slightly protruding, dark-purplish red with pale yellowish inner margins; ocelli present, small and inconspicuous, frequently concealed by local hypodermal pigmentation, situated far forward; posterior ocelli close to margins of eyes, front one on apex of prolonged vertex of the head. Mouth cone rather short, reaching only to middle of prosternum; maxillary palpi long and slender; sides of labrum straight, its point blunt. Antennæ inserted below vertex, approximate at base, slightly more than one and one-half times as long as the head, quite slender; relative lengths of segments as follows:

$$\frac{1}{7.5}\quad\frac{2}{13}\quad\frac{3}{18.2}\quad\frac{4}{17.8}\quad\frac{5}{13.6}\quad\frac{6}{12.1}\quad\frac{7}{11.6}\quad\frac{8}{8}$$

Segments one and two concolorous with head; three pale yellow; rest of antenna shading gradually to dark brown at tip, except bases of four and five, which are pale yellow; spines and sense cones short and inconspicuous.

Prothorax small, scarcely two-thirds as long as head. One spine at each posterior angle alone prominent; those at fore angles smaller than the anterior marginals; ali indistinct; midlaterals wanting; posterior marginals small and not visible except on lightest specimens with careful focusing. Pterothorax approximately as wide as abdomen; its sides nearly straight and parallel. Wings present; hind fringe of fore wing double for five or six hairs near tip. Legs long and slender; fore coxæ projecting strongly; fore femora scarcely thickened and tarsi unarmed; one spine near base of each femur below much longer than others on legs and longest on fore femora; legs concolorous with body.

Abdomen long and slender, cylindrical to about seventh segment, about twice as wide as head, from seventh segment tapering quite gradually to tube. Tube short, only one half as long as head; its sides straight and converging slightly; width at middle about one-third width of head; terminal hairs about as long as tube. Spines at sides of abdomen slender, pale, and not very prominent; segments usually overlapping considerably; sides darkest in color.

Described from eight females.

Cotype.—Cat. No. 6336, U.S.N.M.

Male.—Male about five-sixths as large as female, though antennæ are of about same size in both sexes; relative lengths of segments as follows:

$$\frac{1}{8} \quad \frac{2}{12} \quad \frac{3}{16.5} \quad \frac{4}{16} \quad \frac{5}{13} \quad \frac{6}{12.5} \quad \frac{7}{11} \quad \frac{8}{8}\,.$$

Abdomen much smaller than in female and tapering gradually from base to tip.

Described from one specimen.

Food plant.—Grape.

Habitat.—Amherst, Massachusetts.

Genus IDOLOTHRIPS Haliday.[a]

Anterior ocellus remote from the base of the antennæ. Proboscis reaching the base of the prosternum; labial palpi papilliform; vein one of the fore wings shortened by one-half or abbreviated. Head very long, rounded; abdomen hollowed out. Antennæ slender, three or four times as long as the thorax; prothorax unequally tuberculated; metatarsi unarmed. Size large, marked with three or more lines.

In this genus I find only the species *coniferarum.*

IDOLOTHRIPS CONIFERARUM Pergande.

Plate X, figs. 107–110.

Idolothrips coniferarum PERGANDE, Entom. News, VII, 1896, pp. 63–64.
Idolothrips coniferarum TRYBOM, Festskrift för Lilljeborg, 1896, p. 218.

[a] This generic description is translated from Haliday's original description.

Female.—Length about 4 mm. (3.34 to 4.26 mm.); breadth of mesothorax 0.55 mm. (0.50 to 0.60 mm.). Color coal-black without markings.

Head long and cylindrical; proportional length more variable than in most species, but averaging about two and one-third times as long as wide; surface of head transversely finely striated; cheeks set with a number of short, stout spines; head broadened a trifle just before the neck-like constriction at the base; vertex produced into a very prominent, conical hump in front of the eyes and overreaching the insertion of the antennæ. Eyes large, finely faceted, bulging slightly, extending as far around on under side of head as on upper; ocelli small, widely separated, the anterior one occupying the extreme vertex; the posterior ones, nearly on a line with the middle of the eyes and close to their margins, are often invisible, unless in favorable light, owing to the opacity of the head. Mouth cone short and rounded. Antennæ approximate at base, inserted under the vertex, only about one and one-sixth times as long as the head, and slender; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
12	19	38	32	26	17.5	13.3	15

Segment one concealed at base; three to five clavate; six to eight fusiform. Three mostly yellow (two-thirds); four nearly one-half, and five about one-third yellow; rest of antenna brown-black. Spines and sense cones light and inconspicuous, but the cones especially are long, slender, and acute; three apparently bears only one sense cone, and that is on outer side; six has but one, which is on inner side; four and five have four each.

Prothorax small, only about two-fifths as long as head; only the one long spine on the outer angle of each fore coxa is at all conspicuous. Pterothorax appears nearly square; sides straight and parallel; more than twice as wide as head. Wings present, but short as compared with great length of abdomen, not reaching beyond fifth or sixth segment, heavily fringed; hind fringe of fore wing double for about 26 hairs near tip. Legs short as compared with length of body; fore femora but slightly thickened and tarsi armed with a tiny tooth; legs set with a number of quite long, slender, black spines. Legs black, except fore tibiæ dark yellowish brown along middle of inside, and all tarsi dark brown.

Abdomen extremely long and slender, about two-thirds the length of the entire body and less than one-fourth as wide at base as it is long; tapers gradually from second segment to tube. Tube of female fully five-sixths as long as head and a little more than one-third the width of head; terminal hairs weak and only about two-thirds the length of the tube; spines on sides of abdomen short and weak.

Redescribed from four females.

Male. Contrary to the usual rule, these two specimens are longer than the females, being 4.22 mm. (4.34 to 4.10 mm.). They are somewhat more slender, especially through the middle of abdomen. Heads about two and two-thirds times as long as wide; antennæ longer than in female, about one and one-fifth times as long as head; relative lengths of segments as follows:

$$\frac{1}{14}\quad\frac{2}{20}\quad\frac{3}{42}\quad\frac{4}{34}\quad\frac{5}{29.5}\quad\frac{6}{21.5}\quad\frac{7}{14.5}\quad\frac{8}{15.5}$$

Prothorax nearly one-half as long as the head; fore femora considerably thickened (almost as broad as the head) and each fore tarsus bearing an extremely stout tooth; fore tarsi and inside of tibiæ yellow.

Abdomen at second segment only two-elevenths as broad as long; tube three-fourths as long as head and very slender.

Male newly described from two specimens.

Food plants.—*Pinus iops*, *Juniperus virginiana*, and *Abies* sp.

Found on either green or dry branches in spring and early fall and hibernating under bark.

Habitat. Near Washington, District of Columbia; Amherst, Massachusetts.

UNCLASSIFIED DESCRIPTIONS.

LIMOTHRIPS TRITICI (Fitch) Packard.

"The females alone are winged, the males being wingless and closely resembling the larvæ. The body of the female is smooth and shining, uniformly greenish yellow, with no other markings; the legs are a little paler toward the articulations. The antennæ are eight-jointed, slightly longer than the head; the two basal joints are the largest; the three succeeding joints equal, regularly ovate, the sixth a little longer than the fifth; seventh and eighth minute, seventh a little shorter than eighth, each joint bearing four large bristles. This species differs from the European *L. cerealium* in having but eight joints, the seventh and eighth being minute, and with no intermediate short one, as described in the European insect.

"The prothorax is square, the scutellum short, crescent-shaped, and the abdomen is long and narrow, smooth and shining, ten-jointed. Length, four one-hundredths of an inch, or less than half a line.

"The larva (fig. 2) is entirely greenish yellow, the head and prothorax of the same color as the rest of the body. The eyes are reddish. The feet and antennæ are whitish, not annulated, as in *L. cerealium*. The feet (tarsi) consist of but a single joint ending in a point.

"The male differs from the larva in having two-jointed feet (tarsi) and seven-jointed antennæ, those of the larva being four-jointed. The second joint is exactly barrel-shaped, with two ridges or lines surrounding it, third and fourth joints long, ovate, the third being a lit-

tle larger than the fourth, and with about twelve transverse lines, there being about eight on the fourth joint, from the end of which projects a remarkable tubercle, as seen in the figure. The fifth joint is square at the end, with about eleven transverse lines, and three or four stout hairs externally; sixth joint minute and spherical, while the seventh is three times as long as the sixth, and is finely striated, and with four unequal stout hairs. It is just twice the length of the female, measuring 0.08 inch."

THRIPS TRIFASCIATUS Ashmead.

"*Female.*—Length 0.8 mm. Light brown; eyes strongly faceted, purplish-brown in certain lights; three basal segments of the abdomen above, dark brown; segments 4, 5, and 6 white; apical segments light brown, the sutures dusky; legs, except hind femora toward tips, white; wings linear, strongly fringed, without nerves, the ground color brown or fuscous, with three transverse white bands, i. e., the front wings have a white band at base, another at about two-thirds their length, and with the apices white.

"*Habitat.*—Near Utica, Mississippi."

THRIPS SECTICORNIS Trybom.

I have been unable to see the description of this species which was published in Öfversigt af k. Vetenskaps-Akademiens. Förhandlingar, 1896, page 620.

PHLŒOTHRIPS MALI Fitch.

"This insect measures only six-hundredths of an inch in length and one-hundredth in width. It is polished and shining, and of a blackish purple color. Its antennæ, which are rather longer than the head and composed of eight nearly equal joints, have the third joint of a white color. The abdomen is concave on its upper side, and is furnished with a conical tube at its tip which has a few bristles projecting from its apex. The wings when folded are linear, silvery-white, and as long as the abdomen; they are pressed closely upon the back, spreading asunder at their bases, and appear like an elongated Y-shaped mark. Viewed from above, the head is of a square form, longer than wide. The first segment of the thorax is well separated from the second, is broadest at its base, and gradually tapers to its anterior end, where it is as wide as the head. The following segment is the broadest part of the body and square, with its length and breadth equal."

PHLŒOTHRIPS CARYÆ Fitch.

"This insect is 0.07 long, of a deep black color and highly polished. Its head is narrower than the thorax and nearly square. The third, fourth, and fifth joints of the antennæ are longer than the others, yellow, and slightly transparent; the last joint is shortest and but half as

thick as those which precede it. The abdomen is egg-shaped, with its tip drawn out into a tube thrice as long as it is thick, with four long bristles at its end, and the abdomen is furnished with bristles at each of its sutures. The wings do not reach the tip of the abdomen. They are white and slightly transparent and fringed with black hairs. In its larva state it has a more slender linear form with a dull greenish yellow head, a white thorax with a broad black band anteriorly, a pale red abdomen with a black band at its tip, and whitish legs."

FOSSIL THYSANOPTERA.

Tiny though they are, these insects are not unknown as fossils. The White River deposits are the only ones in this country from which they are yet known. Three species, representing as many genera, have been found there in Tertiary rocks, and have been described by Dr. S. H. Scudder (174, 336), whose descriptions of these insects follow. The last two genera are extinct. Of the genus *Melanothrips*, no living representative has as yet been found in this country, though a species of this genus is known in Europe.

MELANOTHRIPS EXTINCTA Scudder.

Melanothrips extincta Scudder, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, p. 221; Rept. U. S. Geol. Surv. Terr., XIII, 1890, p. 371.

"Head small, tapering; the only appendages visible are the antennæ; these are only sufficiently preserved to recognize that they are very long and slender, longer than the thorax. The thorax is rather small, quadrate; wings nearly as long as the body, fringed on the costal border as in *Palæothrips fossilis*. The abdomen is composed of only eight joints, but is very long and very tapering, fusiform, the last joint produced, as usual in the Physapods; the third joint is the broadest; of the wings only the costal border and a part of one of the longitudinal veins can be seen; there are no remains of legs.

"Length of body, 2.2 mm.; of antennæ, 0.8 mm.; of head, 0.14 mm.; of thorax, 0.5 mm.; of abdomen, 1.56 mm.; greatest breadth of abdomen, 0.5 mm.

"Chagrin Valley, White River, Colorado. One specimen, W. Denton."

Genus LITHADOTHRIPS Scudder.

Lithadothrips Scudder, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, p. 221; Rept. U. S. Geol. Surv. Terr., XIII, 1890, p. 372.

"Allied to Melanothrips Haliday. The head is large, broad, globose; the eyes exceedingly large, globose, each occupying on a superior view fully one-third of the head; the antennæ very slender, equal, as long as the thorax, the joints eight or nine in number, cylindrical, equal, scarcely enlarging toward their tips. The prothorax is no

larger than the head, of equal breadth with it, the whole thorax shaped as in Palæothrips. Only fragments of the wings remain, sufficient to render it probable that they agree well with the character of the group to which Melanothrips and Æolothrips belong. The legs resemble those of Palæothrips, but are slender and appear to be rather profusely supplied with hairs. The abdomen differs considerably in the two specimens referred to this genus. In one it is very broadly fusiform, the tip a little produced, nine joints visible, the apical furnished with a few hairs, and bluntly rounded at the tip; the other has the sides equal, the apex not at all produced, but very broadly rounded, only seven or eight joints vaguely definable.

"A single species is known."

LITHADOTHRIPS VETUSTA Scudder.

Lithadothrips vetusta SCUDDER, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, p. 222; Rept. U. S. Geol. Surv. Terr., XIII, 1890, p. 372.

"The specimens, both of which represent the upper surface of the body with fragments and vague impressions of the members, are too poorly preserved to add anything to the above description of their generic features, excepting the following measurements:

"*First specimen.*—Length of body 1.76 mm., of antennæ 0.6 mm., of thorax 0.6 mm., of abdomen 0.87 mm.; breadth of head 0.28 mm., of thorax 0.52 mm., of abdomen 0.56 mm.; length of fore femora, 0.37 mm. (; breadth of same, 0.14 mm.; length of hind femora, 0.42 mm.; breadth of same, 0.13 mm.

"*Second specimen.*—Length of body 1.96 mm., of antennæ 0.76 mm., of thorax 0.56 mm., of abdomen 1.10 mm.; breadth of head 0.38 mm., of thorax 0.59 mm., of abdomen 0.59 mm.

"Fossil Canyon, White River, Utah. Two specimens. W. Denton."

Genus PALÆOTHRIPS Scudder.

Palæothrips SCUDDER, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, p. 222.

"This genus is allied to Æolothrips Haliday. The head is small, globose; eyes rounded, much smaller than in Lithadothrips; antennæ slender, fully as long as the thorax, not more than seven jointed, the joints cylindrical, subequal. Prothorax considerably larger than the head, the thorax as a whole very large, stout, and tumid; fore femora very stout, scarcely more than twice as long as broad; fore tibiæ also stout, a little longer than the femora; the other legs are moderately stout, long, reaching beyond the tip of the abdomen, with a few scattered, rather short, spinous hairs; the hind tarsi three jointed, the last joint smaller than the others, and altogether two-sevenths the length of the tibiæ. Fore wings unusually broad, broadest apically, where their breadth more than equals one-fourth of their entire length, provided with two longitudinal veins, dividing the disk into three nearly

equal portions, connected in the middle by a cross vein, and with either border by other cross veins at about one-third and two-thirds of the distance from the base to the tip of the wing; the wing is heavily fringed, especially along the hind border. Hind wings veinless, nearly as long, and at the tip nearly as broad, as the fore wings. Abdomen nine jointed, half as long again as the thorax, rather tumid, scarcely or not at all produced apically."

PALÆOTHRIPS FOSSILIS Scudder.

Palæothrips fossilis Scudder, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, pp. 222–223.—Zittel, Handb. d. Palæontology, I, Pt. 2, 1885, p. 784, fig. 999; Rept. U. S. Geol. Surv. Terr., XIII, 1890, pp. 373–374.

"Head small, tapering a little in front, where, however, it is broadly rounded. The antennæ are certainly seven jointed, and none of the apical joints show any indication of being connate, the last joint being of the same length as the two preceding it, tapering, and bluntly pointed; none of the joints show any enlargement in the middle, but the middle joints are slightly larger at the distal extremity than at the base; they appear to be destitute of hairs. The prothorax is subquadrate, a little broader than long, with rounded sides; the fore femora are unusually stout, as long as the width of the prothorax. The longitudinal veins of the fore wings approach each other somewhat abruptly in the middle, where they are united by a cross vein, and at the tip of the wing they curve away from each other; the two cross veins on the lower third of the wing are, respectively, slightly farther from the base of the wing than the corresponding veins of the upper third; the fringe on the posterior border is largest near the tip of the wing, where the hairs are about three times as long as those on the costal border. The first hind tarsal joint is scarcely longer than broad, cylindrical; the second of about the same length, but decidedly broader at apex than at the base; the apical joint is nearly globular, smallest at base, as large in the middle as the base of the other joints. There are a few hairs at the tip of the abdomen and a few short ones on the hind tibiæ; the apical ones stouter than the others, resembling spines; but the insect appears to have been unusually destitute of hairs, excepting on the wings, where not only the edges but also all the veins are fringed.

"Length of body 1.6 to 1.8 mm.; of antennæ 0.58 mm.; of fore femora 0.32 mm.; breadth of same 0.14; length of fore tibiæ 0.32 mm.; of hind femora 0.38 mm; breadth of same 0.11 mm.; length of hind tibiæ 0.42 mm.; of hind tarsi 0.12 mm.; of fore wings 1.4 mm.; of hind wings 1.27 mm.; greatest breadth of fore wings 0.37 mm.; length of prothorax 0.16 mm.; breadth of same 0.32 mm.; length of whole thorax 0.64 mm.; of abdomen 0.92 mm.; greatest breadth of the same 0.37 mm.

"Fossil Canyon, White River, Utah. W. Denton."

GENERAL CONSIDERATIONS.

As has been shown in Jordan's conclusion in regard to the systematic position of this group (see p. 82), Thysanoptera have branched off from the line of the Orthoptera-Hemiptera and resemble the Homoptera more closely than they do any other group.

Starting with a given form which we may call Prothysanopteron, I believe that changes in the degree of development of any of its organs must be correlated with changes in its habits and environment. What was Prothysanopteron like? Judging from its line of phyllogeny, it must certainly have been an active running and flying insect, having elongated mouthparts which were probably becoming suctorial in function and bearing near the other extremity of the body a saw-like ovipositor. Having these organs which would be concerned in the chief relations of its life to its environment—nutrition, locomotion, and reproduction—what can we infer as to the habits of that primitive insect? It fed externally upon the juicy parts of plants, probably puncturing them with its elongated mouthparts and sucking up the exuding juices. It flew from flower to flower or tree and ran about actively thereupon. In the tissue of its food plants it deposited its eggs, cutting the necessary slits for them with its saw-like ovipositor. Its legs, used chiefly in running or crawling, would present few, if any, modifications, while its wings, though surely slender, were probably broad as compared with those found in the order to-day, and the hairs which happened to stand along their edges had begun to elongate so as to compensate, in some degree, for the narrowness of the membranes. With such an insect and such habits as this hypothesis suggests, if we can name reasonable changes in habits which, acting in accordance with the laws of Nature as we know them to be acting to-day, will produce the various forms of insects which we now include in this order, we feel that our hypothesis can be as well sustained as any such hypothesis with reference to primitive forms is capable of being.

If some of the descendants of our external-feeding Prothysanopteron in their struggle for existence should, in the course of numerous generations, acquire a habit of feeding in some well-protected part of the plant, e. g., inside the closely rolled central leaves of *Yucca filamentosa*, where they would be comparatively safe from the attacks of their enemies (a change of habit easily produced by natural selection), then, this environment being favorable, they would no longer find as frequent or as urgent use for their wings and legs as had their ancestors, and they would be favored by remaining in a very restricted place. As a result, wings would degenerate from disuse, and the movements of the insects upon their feet would become slower. Wings might, and probably would, be a distinct disadvantage in such a restricted habitat, so that many influences would tend toward their reduction.

which, however, could not be complete without entailing a decided disadvantage to the species by hindering its spread to other food plants. Nature has established her line of equilibrium somewhere between the two extremes, and we have a majority of short-winged individuals favored by the absence of long wings, but yet in nearly every species will be preserved in some sex, generation, or individuals fully developed wings to assist in the spreading of the species. This line of "balance" will be affected by nearly every habit of the species, so that we may naturally expect to find it in different places in species having different habits, and such is indeed the case. (See p. 105.)

Such a change of habit from frequenting an exposed to a protected feeding ground would affect other organs than the wings. There would no longer be any need of embedding the eggs for protection, and should the atmosphere prove sufficiently moist, they would undoubtedly develop though laid upon the surface of the leaf or stem. This would save much of the energy of oviposition, and in the course of time the practice of embedding the eggs would cease altogether. Having now no use for the ovipositor, that, too, would degenerate from disuse till, at most, a mere vestige would remain of this originally well-developed organ. Some such course of development I believe to have taken place in the Phlœothripidæ, and the chitinous rod now found on the underside of the ninth abdominal segment just in front of the sexual opening seems best explainable as the remaining vestige of the former ovipositor. (See Plate X, fig. 115.) As the ovipositor became weaker and weaker other changes correlated to this must have been in progress. The sheath which had contained the ovipositor, being no longer needed, would naturally become closed up. The ventral plates which had previously disappeared to provide room for the sheath would not again develop, but the edges of the dorsal plates closing around still further would meet on the ventral line forming the tube of the Tubulifera. At the same time the sexual opening seems to have moved backward till it reached the hind part of the ninth segment, where it is now found.

Other modifications of the Prothysanopteron, found in the Tubulifera (mainly), may logically be traced to this one change of habit. I refer to the trapezoidal form of the prothorax, the enlargement of the fore legs, and the development of a tooth upon the fore tarsus which thereby has lost one segment in a large number of forms, also the flattened character of the body, and possibly its elongation.

In regard to the modifications of the prothorax and the fore pair of legs, it is very evident that they may all be related to the one simple change of habit in regard to the place of feeding, which has been assumed. Naturally considerable effort would frequently, perhaps usually, be required to drag their bodies through such narrow places as those in which they lived. Any variation in the line of a more

powerful development of the muscles of the fore legs or of any modification of the tarsus which would tend to give a firmer hold in crawling, being favorable to the insect, would be preserved by natural selection, and thus in the course of many generations the tarsal tooth and the powerful, thickened femora of most Tubulifera would be developed. There would also be a correlative broadening and flattening of the prothorax, which would necessarily result in pushing farther apart the fore coxæ, which are attached to its hind angles. The logical result of these changes is the trapezoidal form of the prothorax always found in those species having such thickened femora and well-developed tarsal hooks.

The elongation and flattening of the body are doubtless referable in some degree to the same change in the conditions of external life, for such a changed form would certainly have been favorable to its possessors, and we are surely safe in assuming that the favorable changes are the ones which have been preserved, while the unfavorable ones have been eliminated. We do not presume to say that all the descendants of Prothysanopteron followed this suggested line of change; some of them certainly may have done so. Neither do we presume that all the descendants of those which did follow some such line of development would continue in an even similar environment till all the modifications which have been named had been accomplished. We have just as much reason to expect a change of environment anywhere along the phyllogenetic line as at its beginning, and such changes certainly must have taken place. What would be the result if this were the case? Different environments acting upon different subjects, or even upon like subjects, would favor entirely different variations. Structures which had become developed during the changes subsequent to Prothysanopteron might be lost, but those that had been lost could never again be developed in their original form; e. g., tarsal teeth and thickened femora might develop and then disappear, but an ovipositor of the original type would never again be found in the Tubulifera. We would expect then that the descendants of Protubuliferan would vary in habits, habitat, form, and life rather than in the tubular nature of the terminal segment of the body. Such is indeed the case, and so while there do take place great modifications of each organ, the presence of the tube is constant. We feel justified in concluding that the family Phlœothripidæ has now diverged far more widely from Prothysanopteron than has either of the families of the Terebrantia.

The two families constituting the suborder Terebrantia resemble each other quite closely in many respects. We find between them no such marked points of difference as we do between each of them and the Phlœothripidæ. The principal differences which do exist are mainly various modifications of the same organ, and the most impor-

tant structures which we must notice are the antennæ, wings, and ovipositor. What are the chief points of difference that we find in the structure of these organs? Only a modification in the structure of each organ has taken place. In Æolothripidæ we find always nine segmented antennæ, comparatively broad wings, which are rounded at their extremities, and have, in the fore wing, the fore fringe and the spines along its veins very weakly developed, a strong ring vein, two longitudinal veins, and four or five cross veins, and finally a strongly developed ovipositor, which curves upward toward the tip of the abdomen. In Thripidæ we find antennæ with from six to eight segments, wings which are nearly always slender and quite sharply pointed at their tips; that in the fore wing the fore fringe and numerous spines along its veins are nearly always well developed, two (sometimes only one) longitudinal veins are present, the ring vein is rarely strongly developed, cross veins are absent or but slight traces of them occasionally appear, the ovipositor is moderately well developed in most cases, but sometimes is small, weak, and functionless, though it is always plainly present and curves downward away from the tip of the abdomen.

Between these two families we shall find it much more difficult to decide just what influences may have favored the development of the differences noted. Certainly many influences were concerned, and they could not have been of such a nature as to favor such radical changes as have resulted in the development of the Tubulifera. Rather than attempt to outline these varied influences and their probable results, we prefer, in this case, to base our conclusions upon the general tendencies which now appear to be acting, and which we may reasonably assume to have been acting in the same way during much, perhaps all, of the past history of this suborder.

We have shown that Phlœothripidæ have diverged more widely from Prothysanopteron than have any other members of the order. A comparison of the antennæ in the three families will aid us in determining the order in which the families must be arranged. In the Phlœothripidæ these organs are always eight segmented. The intermediate segments are, as a rule, much thicker in the middle than at the ends, and are sometimes rounded. Stout spines are borne around the apical thirds of segments two to six, inclusive, and more slender spines are more generally distributed over the last two segments. A whorl of small spines stands also around the first third of each segment from three to six, inclusive, and simple, stout, specialized sense cones are borne at about the outer third of these segments in most cases. The antennæ of Thripidæ consist of from six to eight segments, of which the intermediate ones are always considerably thicker in the middle than at their ends. Stout spines are usually present around the apical ends of segments two to five inclusive. More slender spines

are generally distributed over segments six, seven, and eight, and from three to five whorls of small spines are often discernible around the middle half of each intermediate segment. Sense cones are found upon segments three to six, inclusive; in some cases these are all simple, though in the majority those upon segments three and four are double or crescentic in form. The antennæ of Æolothripidæ have always nine segments, of which the intermediate ones are always much elongated and regularly cylindrical in form. Stout spines are found only around segment two, while the remaining segments, except the basal, are thickly set with small spines, which are irregularly, but generally distributed. Of these last two types of antenna, that of Thripidæ unquestionably approaches more closely to that of Phlœothripidæ. Granting that the latter exhibits the extreme degree of divergence from the original type, we must place Thripidæ next, and this leaves the antenna of Æolothripidæ as resembling most closely that of Prothysanopteron.

If we examine the wings in like manner, we shall find that both pairs of those of Phlœothripidæ are similar in form, long, slender, and rounded at their ends. Ring vein and cross veins have entirely disappeared. Each wing has only one longitudinal vein, which is median and though quite strong at its base usually disappears before the middle of the wing. The fringes upon both margins are equally well developed and quite similar in all respects. The membrane of the wing is smooth and the veins are not set with spines except for about three, which usually stand near the base of the vein in the fore wing. Thripidæ have wings which differ in many regards from those of Phlœothripidæ just described. The fore and hind wings are dissimilar in many respects. They are both, however, long, very slender (except the fore wing of *Parthenothrips*), and sharply pointed at the tips. The fore wing is always somewhat stronger than the hind wing and has more veins and heavier fringes. There are usually present in it two fully developed longitudinal veins (sometimes only one), and these disappear before reaching the end of the wing. The ring vein, though very strong in the one species of *Parthenothrips*, is weakly developed in most species and in some is hardly distinguishable. Traces of cross veins can sometimes be seen, but they are never strongly developed except the one between the two longitudinal veins at the first third of the wing. While entirely absent (with the exception named as strongly developed) in most species, there may occasionally appear individuals having wings which show traces of cross veins, and it is very significant that these always occur at just the same positions in the wing as are occupied by the cross veins of Æolothripidæ, which will be more fully described in connection with that family. The hind wing has one longitudinal vein which is median, but no ring or cross veins are present. Fringes usually occur upon

both margins of both wings, but are different upon the two margins, the fore fringe being single, shorter, and usually stouter than the hind one. The veins of the fore wing alone bear more or less strongly developed spines which upon the costa may even take the place of the fringe. The membranes of both wings are thickly set with very minute, microscopic spines. In Æolothripidæ we find wings which are long, comparatively broad, and rounded at their extremities. Here also the fore and hind wings are dissimilar in many respects, the fore wing being stronger and far more heavily veined. The fore wing has always a strongly developed ring vein,[a] two longitudinal veins which extend throughout the wing and unite with the ring vein on each side of the tip, and four or five well-developed cross veins situated as described on p. 129. The hind wings have no fully developed longitudinal vein and no trace of cross or ring veins. No fringe is developed on the front margin of the fore wing and only a very short, weak fringe is here present upon the hind wing. The veins of the fore wing bear only short spines and the membranes of both wings are thickly set with small spines which, though minute, are larger than the similar spines in Thripidæ.

Comparing now these three types of wing point by point, and balancing the weight of evidence, we are led to the conclusion that Æolothripidæ and Phlœothripidæ stand at the extremes in respect also to their wings, with Thripidæ somewhere between them but nearer to the former than to the latter group. The strong, constantly developed ring vein of Æolothripidæ has become much weaker or entirely disappeared among Thripidæ, while in the widely divergent Phlœothripidæ no trace of it is found. Cross veins are also disappearing in Thripidæ, and their occasional presence in much the same position in the wing as in Æolothripidæ suggests the idea that they are undergoing degeneration and that this process has gone farther in some species than in others. In Æolothripidæ the longitudinal veins join the ring vein near the tip, in Thripidæ they do not reach this point but taper out and disappear before the tip, while in Phlœothripidæ they rarely reach beyond the middle of the wing. The microscopic spines upon the membranes and the comparative development of the fore fringes both point to this same relation of the families. In only one character do the wings of the extreme groups closely resemble each other—this is in the broadly rounded tips. The Phlœothripidæ being, as we have seen, the most widely divergent group, we must conclude that, so far as wings are concerned, those of Æolothripidæ resemble most closely the wings of Prothysanopteron.

In regard to the ovipositor but little will need to be said. It is always found more strongly developed in Æolothripidæ than in Thrip-

[a] This heavy ring vein is a most remarkable character and, so far as the writer can learn, nothing like it is found in any other order of insects.

idæ, while in Phlœothripidæ it is entirely wanting. Moreover, there exists in Thripidæ a wide variation in the degree of its development, as has already been shown. So in this respect, also, we must place our three families in the same relation to each other, and if Prothysanopteron possessed an ovipositor, as we can not doubt from its phyllogeny must have been the case, the well-developed organ found in Æolothripidæ must very probably approach most closely to the primitive form.

Summarizing the conclusions which we have now reached, we find, first, that the Tubulifera (Phlœothripidæ) have diverged more widely from Prothysanopteron than have either of the families of the Terebrantia. Second, a comparative consideration of antennæ, wings, and ovipositor shows that Æolothripidæ and Phlœothripidæ present the extreme types of these structures found in the order. Therefore we conclude that the Æolothripidæ most nearly preserve the characters present in the Prothysanopteron ancestor of this order. From this it appears that the descendants of Prothysanopteron early divided into two main groups, one of which diverged widely from the original form and has developed the Tubulifera of to-day. The other of these groups continued nearly along the original line, but in time it divided again and a group (Thripidæ) branched off, taking in some respects the direction of Phlœothripidæ, while in the majority of characters it followed a line of its own. The group which still continued most nearly in the original direction includes the insects which we now place in the family Æolothripidæ.

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EXPLANATION OF PLATES.

In the figures of wings of species of Terebrantia the hind fringes are not fully represented on account of their great length.

PLATE I.

Fig. 1. *Æolothrips fasciatus* Linnaeus. Head, prothorax, antennæ, and fore legs of female. $\frac{62}{1}$.

2. *Æolothrips fasciatus*, left fore wing of female. $\frac{62}{1}$.

3. *Æolothrips fasciatus*, end of abdomen of female. $\frac{62}{1}$.

4. *Æolothrips bicolor*, new species. Head, prothorax antennæ, and fore legs of female. $\frac{62}{1}$.

5. *Æolothrips bicolor*, end of abdomen of female. $\frac{62}{1}$.

Fig. 6. *Æolothrips bicolor*, anterior part of abdomen at junction with metathorax showing first abdominal segment of male. $\frac{85}{1}$.

7. *Æolothrips bicolor*, end of abdomen of male. $\frac{85}{1}$.

8. *Æolothrips bicolor*, left antenna of male. $\frac{62}{1}$.

9. Fore tarsal hook present in both sexes of Æolothripidæ. $\frac{213}{1}$.

10. *Limothrips avenæ*, new species. End of abdomen of female. $\frac{85}{1}$.

11. *Limothrips avenæ*, end of abdomen of male. $\frac{85}{1}$.

12. *Limothrips avenæ*, right fore wing of female. $\frac{62}{1}$.

PLATE II.

Fig. 13. *Limothrips avenæ*, new species. End of abdomen of female. $\frac{85}{1}$.

14. *Chirothrips manicatus* Haliday. Head, prothorax, antennæ, and legs of female. $\frac{107}{1}$.

15. *Chirothrips manicatus*, end of abdomen of male. $\frac{107}{1}$.

16. *Chirothrips manicatus*, left fore wing of female. $\frac{62}{1}$.

17. *Chirothrips crassus*, new species. Head, prothorax, and antennæ of female. $\frac{107}{1}$.

18. *Chirothrips crassus*, end of abdomen of female. $\frac{107}{1}$.

19. *Chirothrips crassus*, head, prothorax, antennæ, and fore legs of male. $\frac{107}{1}$.

20. *Chirothrips crassus*, end of abdomen of male. $\frac{107}{1}$.

21. *Chirothrips obesus*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.

22. *Chirothrips obesus*, end of abdomen of female. $\frac{107}{1}$.

23. *Sericothrips variabilis* (Beach). Left fore wing of female. $\frac{107}{1}$.

PLATE III.

Fig. 24. *Sericothrips variabilis* (Beach). Head, prothorax, and antennæ of female. $\frac{107}{1}$.

25. *Sericothrips variabilis*, end of abdomen of female. $\frac{107}{1}$.

26. *Sericothrips variabilis*, end of abdomen of male. $\frac{107}{1}$.

27. *Sericothrips cingulatus*, new species. Head, prothorax, and antennæ of female. $\frac{107}{1}$.

Fig. 28. *Sericothrips cingulatus*, end of abdomen of female. $\frac{107}{1}$.

29. *Sericothrips cingulatus*, end of abdomen of male. $\frac{107}{1}$.

30. *Pseudothrips inequalis* (Beach). Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.

31. *Pseudothrips inequalis*, end of abdomen of female. $\frac{107}{1}$.

32. *Pseudothrips inequalis*, right fore wing of female. $\frac{107}{1}$.

33. *Euthrips nervosus* (Uzel). Head, prothorax, antennæ, and fore legs of female. $\frac{62}{1}$.

34. *Euthrips nervosus*, end of abdomen of female. $\frac{62}{1}$.

PLATE IV.

Fig. 35. *Euthrips nervosus* (Uzel). Right fore wing of female. $\frac{62}{1}$.

36. *Euthrips tritici* (Fitch). Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.

37. *Euthrips tritici*, end of abdomen of female. $\frac{107}{1}$.

38. *Euthrips tritici*, end of abdomen of male. $\frac{107}{1}$.

39. *Euthrips tritici*, left fore wing of female. $\frac{85}{1}$.

40. *Euthrips fuscus*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.

41. *Euthrips fuscus*, end of abdomen of female. $\frac{107}{1}$.

42. *Scolothrips 6-maculatus* (Pergande). Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.

43. *Scolothrips 6-maculatus*, end of abdomen of female. $\frac{107}{1}$.

44. *Scolothrips 6-maculatus*, end of abdomen of male. $\frac{107}{1}$.

45. *Scolothrips 6-maculatus*, right fore wing of female. $\frac{107}{1}$.

PLATE V.

Fig. 46. *Raphidothrips fuscipennis*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{85}{1}$.

47. *Raphidothrips fuscipennis*, end of abdomen of female. $\frac{85}{1}$.

48. *Raphidothrips fuscipennis*, left fore wing of female. $\frac{85}{1}$.

49. *Anaphothrips striatus* (Osborn). Head, prothorax, and antennæ of female $\frac{85}{1}$.

50. *Anaphothrips striatus*, end of abdomen of female. $\frac{85}{1}$.

Fig. 51. *Anaphothrips striatus*, right fore wing of female. $\frac{85}{1}$.

52. *Aptinothrips rufus* (Gmelin). Head, prothorax, and antennæ of female. $\frac{107}{1}$.

53. *Aptinothrips rufus*, end of abdomen of female. $\frac{107}{1}$.

54. *Aptinothrips rufus* var. *connaticornis* Uzel. Antennæ of female. $\frac{107}{1}$.

55. *Heliothrips femoralis* Reuter. Head, prothorax, antennæ, and fore legs of female. $\frac{62}{1}$.

56. *Heliothrips femoralis*, end of abdomen of female. $\frac{62}{1}$.

PLATE VI.

Fig. 57. *Heliothrips femoralis* Reuter. Left fore wing of female. $\frac{62}{1}$.

58. *Heliothrips fasciapennis*, new species. Head, prothorax, and antennæ of female. $\frac{107}{1}$.

59. *Heliothrips fasciapennis*, end of abdomen of female. $\frac{107}{1}$.

60. *Heliothrips fasciapennis*, right antenna of female. $\frac{167}{1}$.

61. *Heliothrips fasciapennis*, right fore wing of female. $\frac{85}{1}$.

62. *Parthenothrips dracænæ* (Heeger). Head, prothorax, antennæ, and fore legs of female. $\frac{62}{1}$.

63. *Parthenothrips dracænæ*, end of abdomen of female. $\frac{62}{1}$.

64. *Parthenothrips dracænæ*, portion of reticulation from head of female. $\frac{213}{1}$.

65. *Parthenothrips dracænæ*, left fore wing of female. $\frac{62}{1}$.

66. *Thrips perplexus* (Beach). Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.

67. *Thrips perplexus*, end of abdomen of female. $\frac{107}{1}$.

68. *Thrips perplexus*, left fore wing of female. $\frac{107}{1}$.

PLATE VII.

Fig. 69. *Thrips tabaci* Lindeman. Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.

70. *Thrips tabaci*, end of abdomen of female. $\frac{107}{1}$.

71. *Thrips tabaci*, left fore wing of female. $\frac{85}{1}$.

72. *Anthothrips niger* (Osborn). Head, prothorax, and fore legs of female. $\frac{62}{1}$.

73. *Anthothrips niger*, end of abdomen of female. $\frac{85}{1}$.

74. *Anthothrips niger*, left antenna of female. $\frac{85}{1}$.

Fig. 75. *Anthothrips niger*, left fore wing of female. $\frac{62}{1}$.

76. *Anthothrips verbasci* (Osborn). Head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.

77. *Anthothrips verbasci*, end of abdomen of female. $\frac{50}{1}$.

78. *Anthothrips verbasci*, left antenna of female. $\frac{85}{1}$.

79. *Trichothrips beachi*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.

PLATE VIII.

Fig. 80. *Trichothrips beachi*, new species. End of abdomen of female. $\frac{50}{1}$.

81. *Trichothrips ambitus*, new species. Head, prothorax, antennæ, and fore femora of female. $\frac{50}{1}$.

82. *Trichothrips ambitus*, end of abdomen of female. $\frac{50}{1}$.

83. *Cephalothrips yuccæ*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.

84. *Cephalothrips yuccæ*, end of abdomen of female. $\frac{50}{1}$.

85. *Phlœothrips pergandei*, new species. Head, antennæ, prothorax, and fore legs of female. $\frac{50}{1}$.

86. *Phlœothrips pergandei*, end of abdomen of female. $\frac{50}{1}$.

87. *Phlœothrips uzeli*, new species. Head, prothorax, antennæ, and fore legs of male. $\frac{50}{1}$.

88. *Phlœothrips uzeli*, end of abdomen of male. $\frac{50}{1}$.

89. *Phlœothrips uzeli*, under side of right fore leg of male. $\frac{85}{1}$.

90. *Phlœothrips uzeli*, upper side of left fore leg of male. $\frac{85}{1}$.

PLATE IX.

Fig. 91. *Phlœothrips uzeli*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.

92. *Phlœothrips uzeli*, end of abdomen of female. $\frac{62}{1}$.

93. *Acanthothrips magnafemoralis*, new species. Head, prothorax, antennæ, and fore legs of male. $\frac{50}{1}$.

94. *Acanthothrips magnafemoralis*, end of abdomen of male. $\frac{50}{1}$.

95. *Malacothrips zonatus*, new genus and new species. Head, prothorax, antennæ, and fore femora of male. $\frac{50}{1}$.

96. *Malacothrips zonatus*, end of abdomen of male. $\frac{50}{1}$.

Fig. 97. *Malacothrips zonatus*, head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.

98. *Malacothrips zonatus*, end of abdomen of female. $\frac{50}{1}$.

99. *Eurythrips ampliventralis*, new genus and new species. Head, thorax, and fore legs of female. $\frac{62}{1}$.

100. *Eurythrips ampliventralis*, end of abdomen of female. $\frac{62}{1}$.

101. *Eurythrips ampliventralis*, left antenna of female. $\frac{85}{1}$.

PLATE X.

Fig. 102. *Eurythrips osborni*, new genus and new species. Head, prothorax, antennæ, and fore legs of female. $\frac{62}{1}$.

103. *Eurythrips osborni*, end of abdomen of female. $\frac{62}{1}$.

104. *Cryptothrips aspersus*, new species. Head, prothorax, and fore legs of female. $\frac{50}{1}$.

105. *Cryptothrips aspersus*, end of abdomen of female. $\frac{50}{1}$.

106. *Cryptothrips aspersus*, right antenna of female. $\frac{85}{1}$.

107. *Idolothrips coniferarum* Pergande. Head, prothorax and fore legs of male. $\frac{33}{1}$.

108. *Idolothrips coniferarum*, end of abdomen of male. $\frac{50}{1}$.

109. *Idolothrips coniferarum*, head, prothorax, and fore legs of female. $\frac{33}{1}$.

110. *Idolothrips coniferarum*, right antenna of female. $\frac{50}{1}$.

111. *Thrips tabaci*, longitudinal-vertical section through anterior part of body showing form of head and thorax and position of nervous system and alimentary canal. $\frac{83}{1}$.

112. *Anaphothrips striatus*, surface view of stigma from first abdominal segment. $\frac{716}{1}$.

113. *Anaphothrips striatus*, cross section through stigma from first abdominal segment. $\frac{716}{1}$.

114. *Anthothrips verbasci*, under side of last two abdominal segments of male; A, notch in base of tube. $\frac{62}{1}$.

115. *Anthothrips verbasci*, under side of last two abdominal segments of female; A, chitinous rod. $\frac{62}{1}$.

PLATE XI.

Fig. 116. *Æolothrips fasciatus*, dorsal view of pterothorax of female. $\frac{62}{1}$. A1, first abdominal tergite; A2, second abdominal tergite; M1, mesoscutum; M2, metascutum; M3, metascutellum.

Fig. 117. *Æolothrips fasciatus*, ventral view of pterothorax of female. $\frac{62}{1}$. C, coxa; ET, endothoracic invaginations; MS, mesosternum; MT, metasternum; S1, first abdominal sternite; S2, second abdominal sternite; T, trochanter.

118. *Heliothrips femoralis*, dorsal view of pterothorax of female. $\frac{62}{1}$. A1, first abdominal tergite; A2, second abdominal tergite; M1, mesoscutum; M2, metascutum; M3, metascutellum.

119. *Heliothrips femoralis*, ventral view of pterothorax of female. $\frac{62}{1}$. ET, endothoracic invaginations; MS, mesosternum; MT, metasternum.

120. *Anaphothrips striatus*, face of female. $\frac{115}{1}$. EC, endocranial thickening at base of mouth cone; LI, labium; LP, labial palpi; LR, labrum; MD, mandible; ML, internal piercing lobe of maxilla; MP, maxillary palpi; MX, maxilla.

121. *Anaphothrips striatus*, side view of end of abdomen of female; ovipositor lowered into position for use. $\frac{107}{1}$.

122. *Æolothrips bicolor*, under side of antennal segments two to five. $\frac{213}{1}$. SA, sense areas.

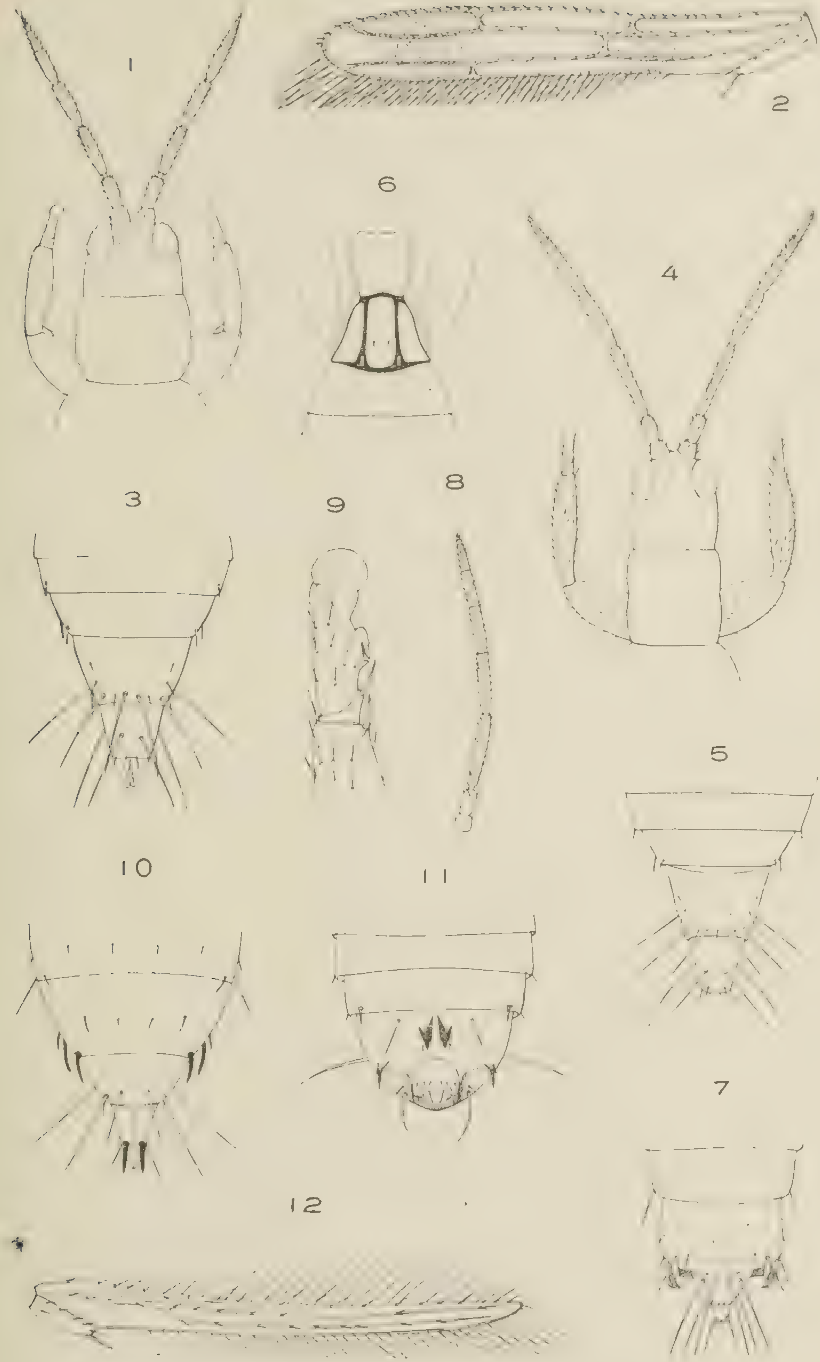
123. *Thrips perplexus*, upper side of antennal segments two to seven. $\frac{213}{1}$. SC, sense cones.

124. *Trichothrips ambitus*, upper side of antennal segments two to seven. $\frac{130}{1}$. SC, sense cones.

125. *Limothrips arenæ*, dorsal view of pterothorax of wingless male. $\frac{107}{1}$. A1, first abdominal tergite; A2, second abdominal tergite; M1, mesoscutum; M2, metascutum.

126. *Anthothrips verbasci*, dorsal view of head and thorax of female. $\frac{62}{1}$. A1, first abdominal tergite; A2, second abdominal tergite; M1, mesoscutum; M2, metascutum; M3, metascutellum.

127. *Anthothrips verbasci*, ventral view of head and thorax of female. $\frac{62}{1}$. ET, endothoracic invaginations; MS, mesosternum; MT, metasternum; S1, first abdominal sternite; S2, second abdominal sternite.



NORTH AMERICAN THYSANOPTERA.

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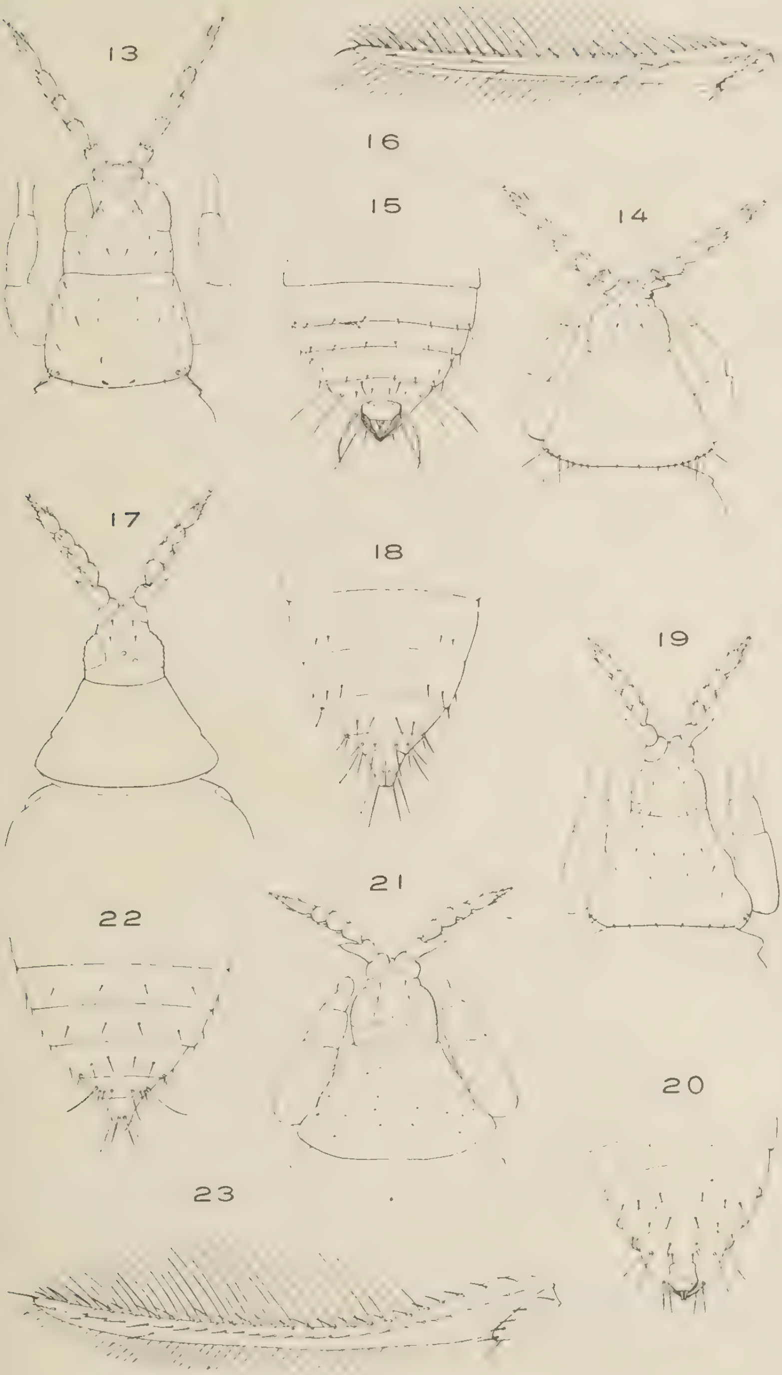

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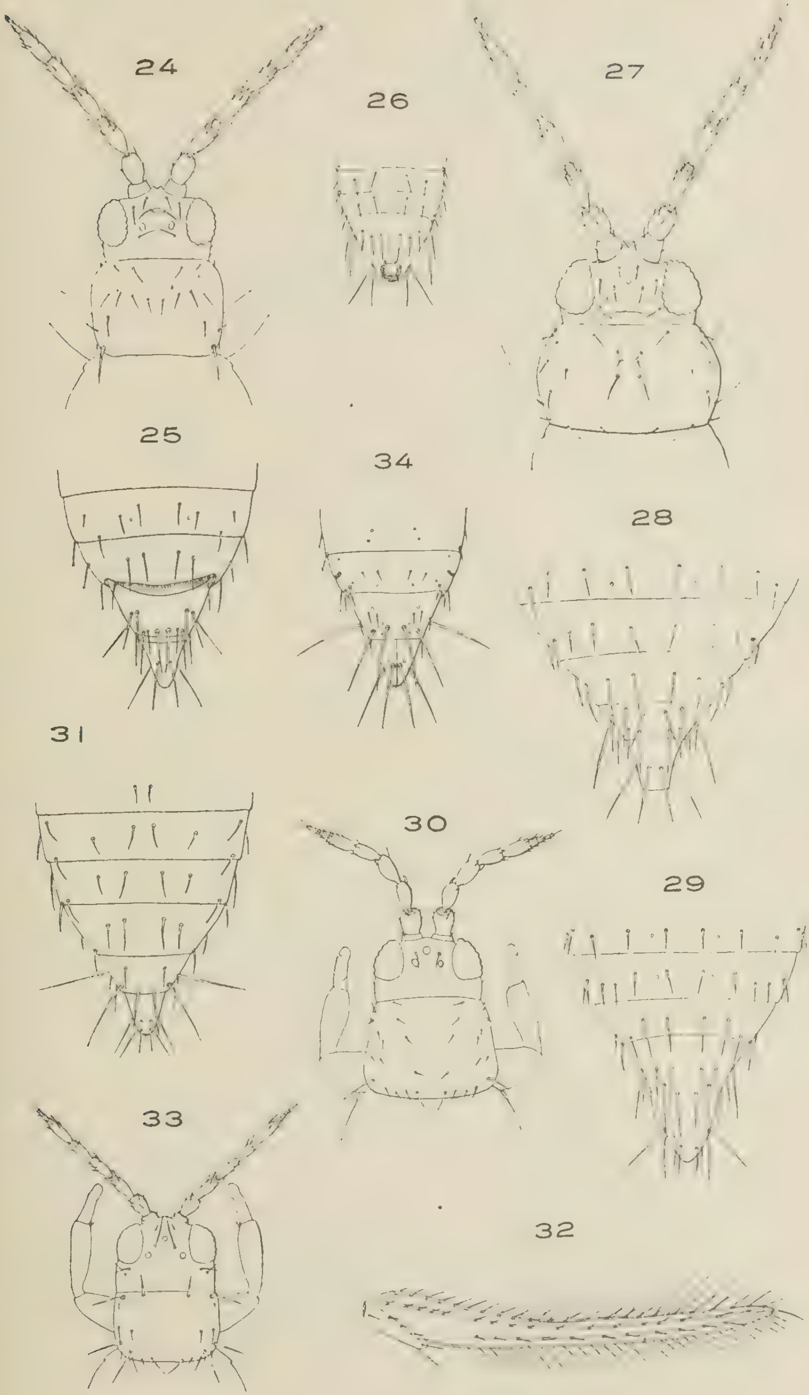

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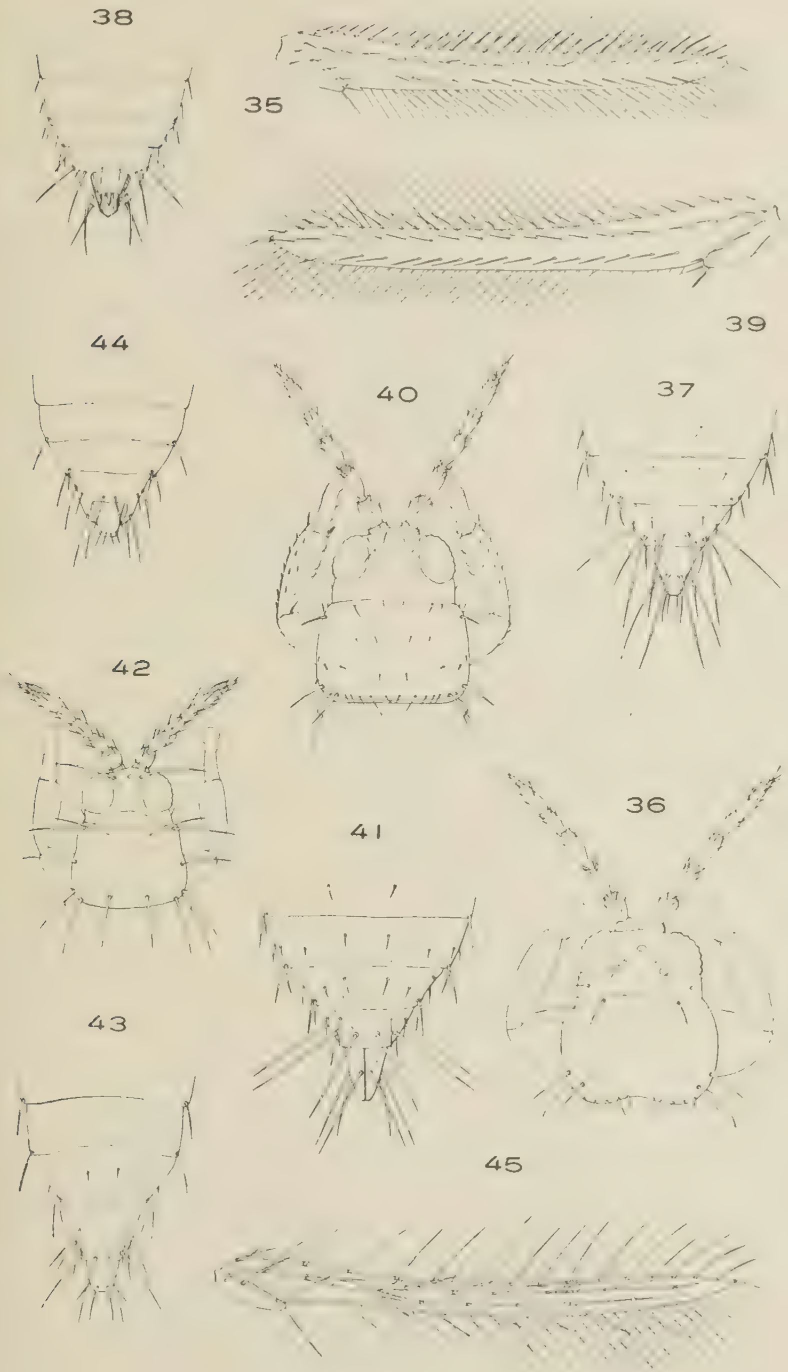

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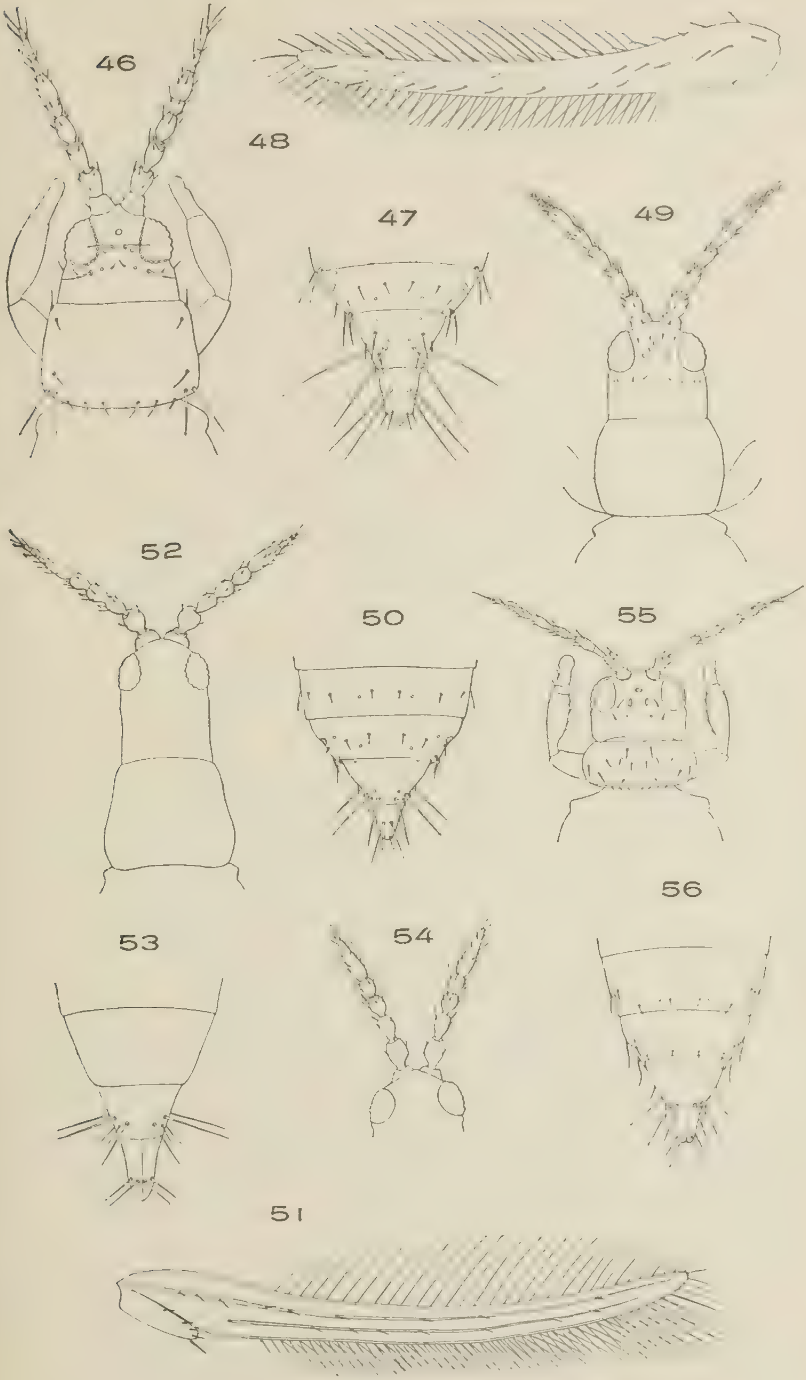

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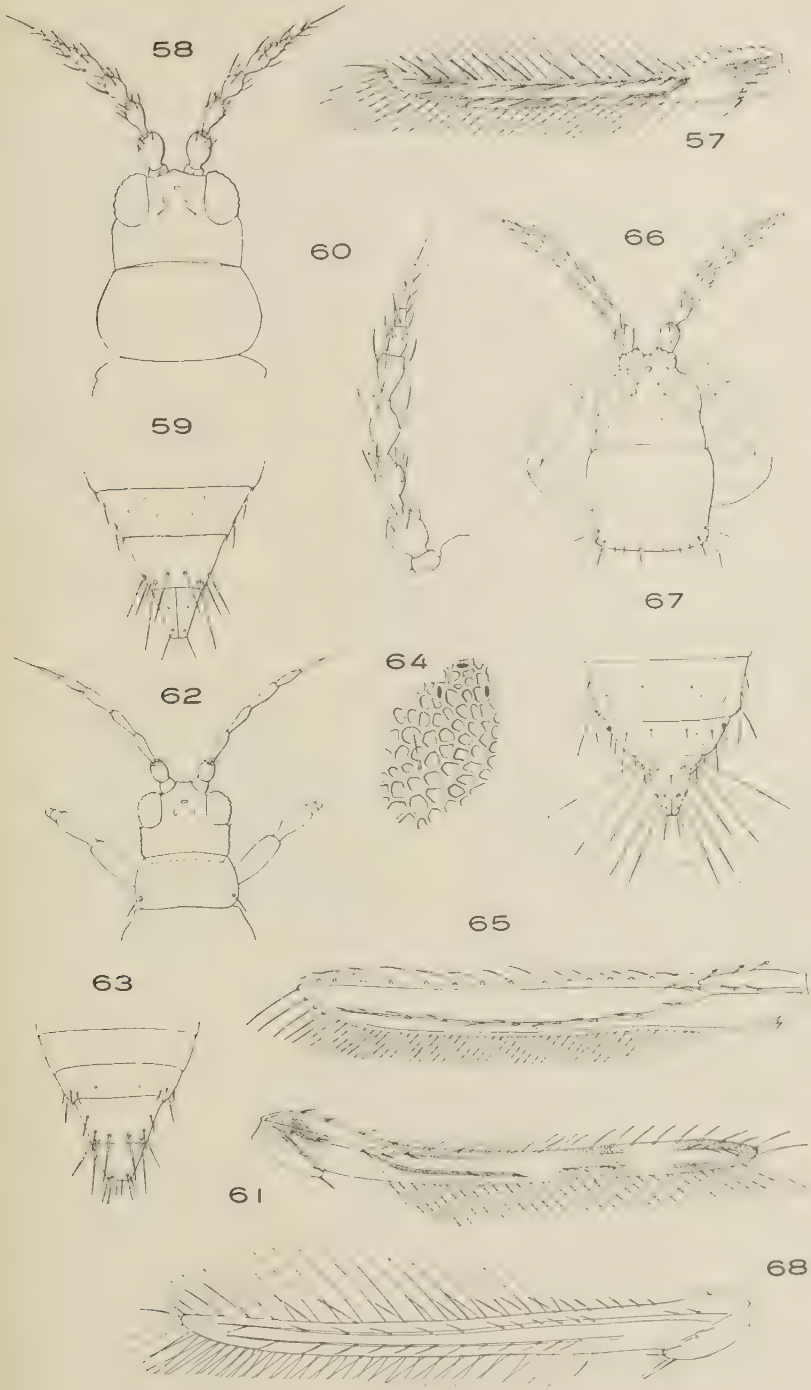

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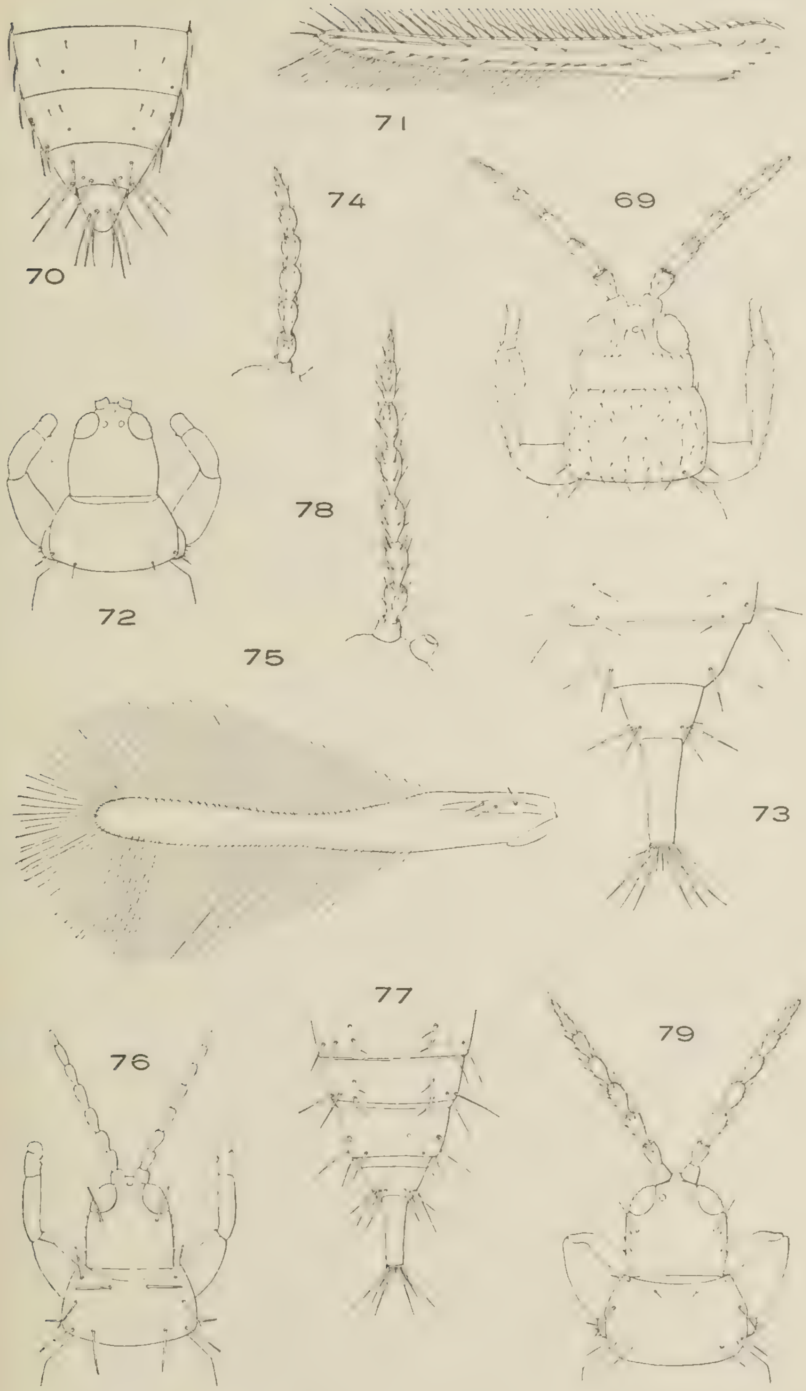

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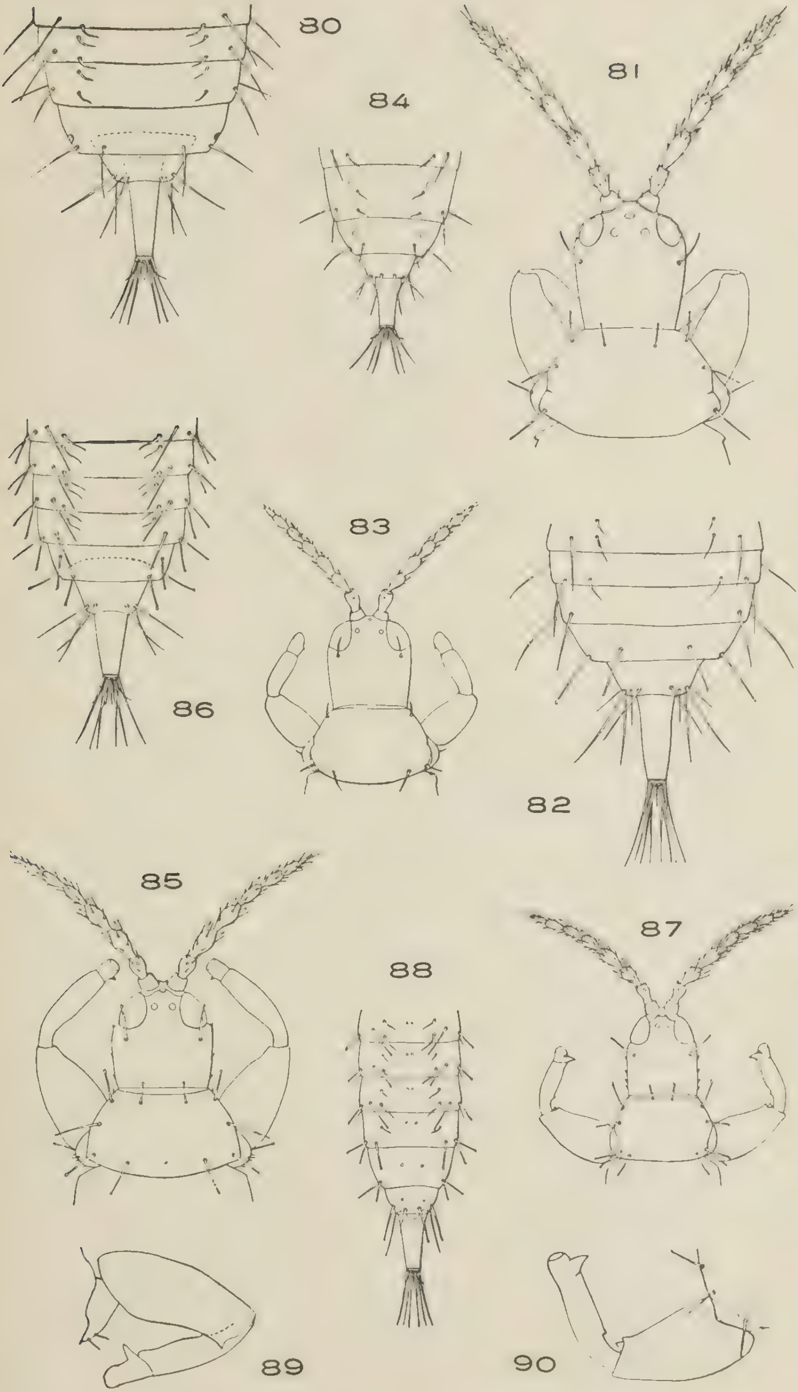

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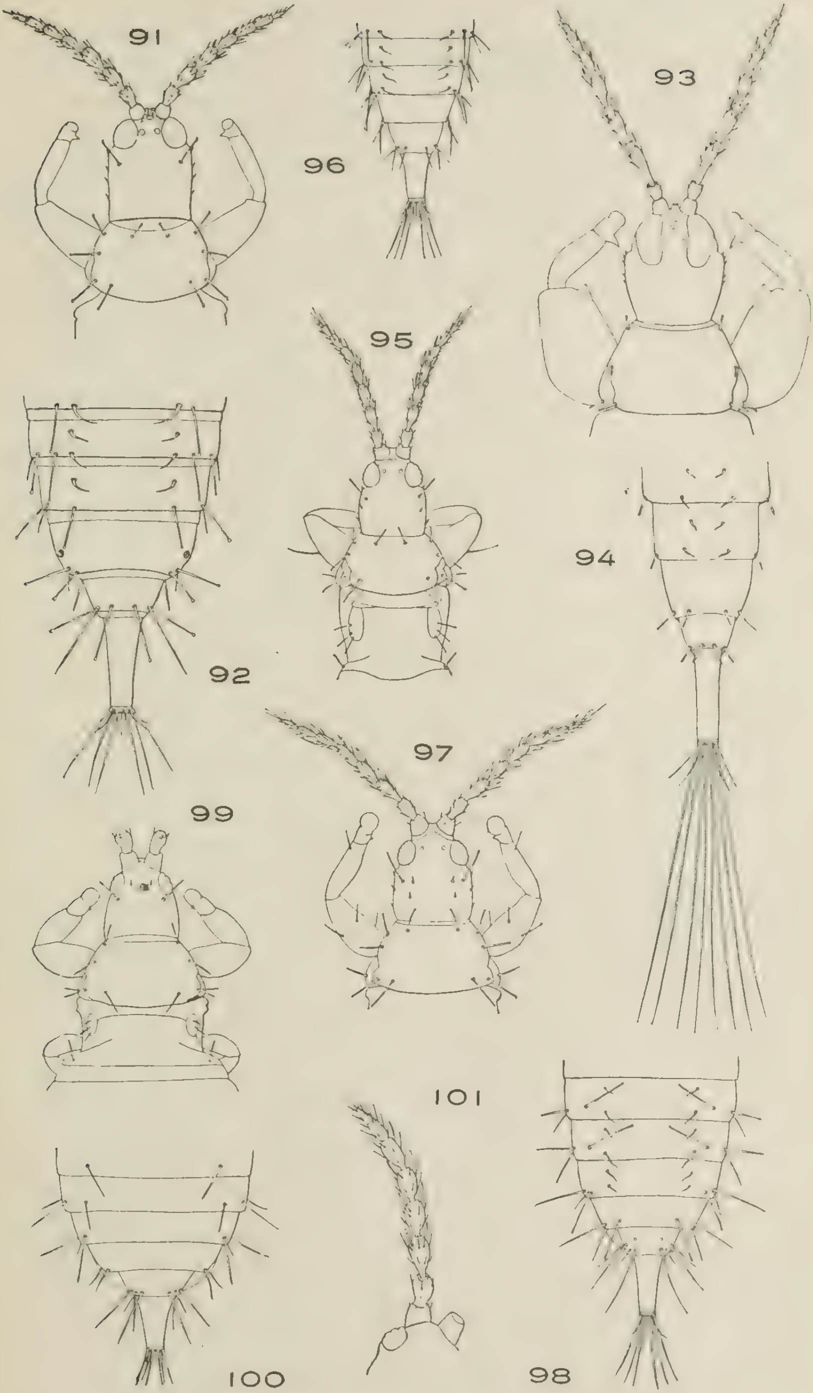

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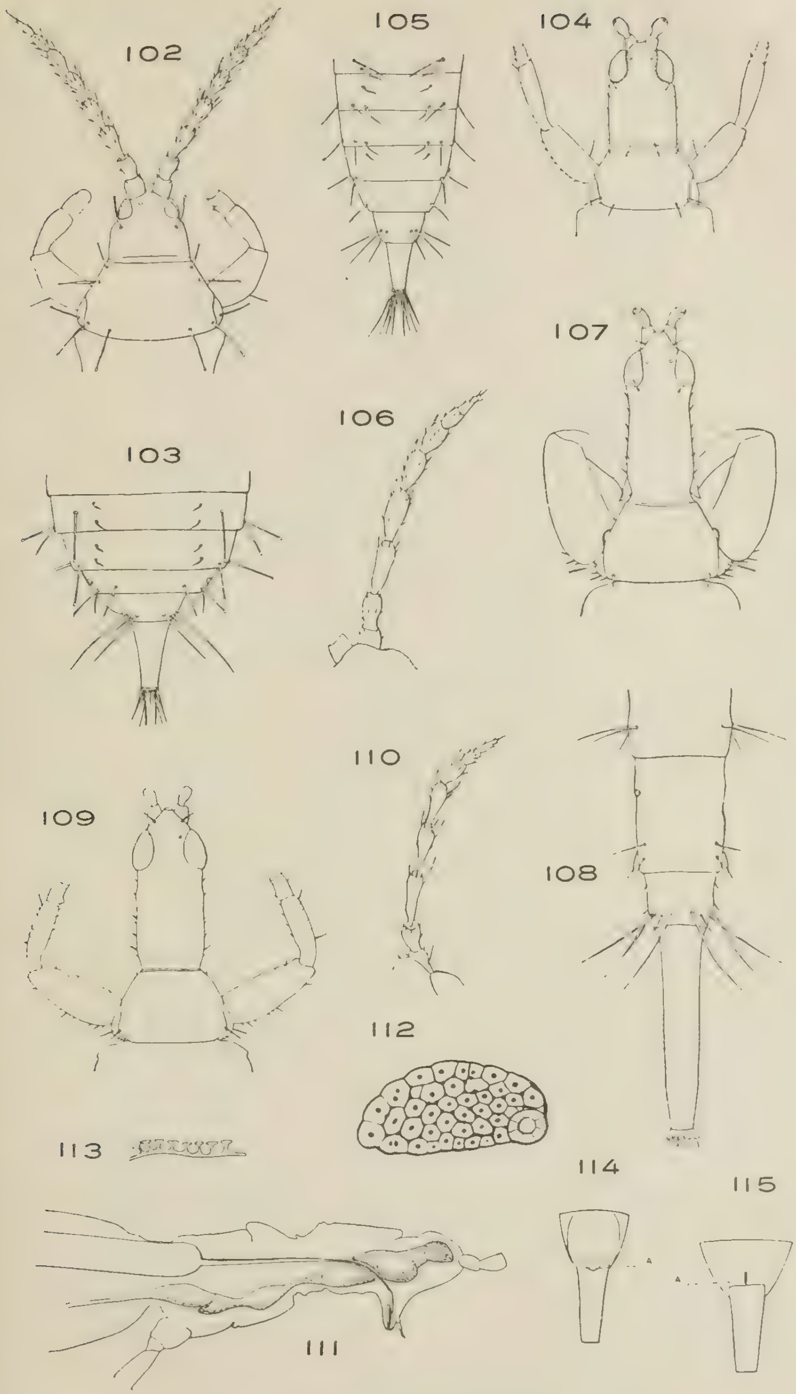

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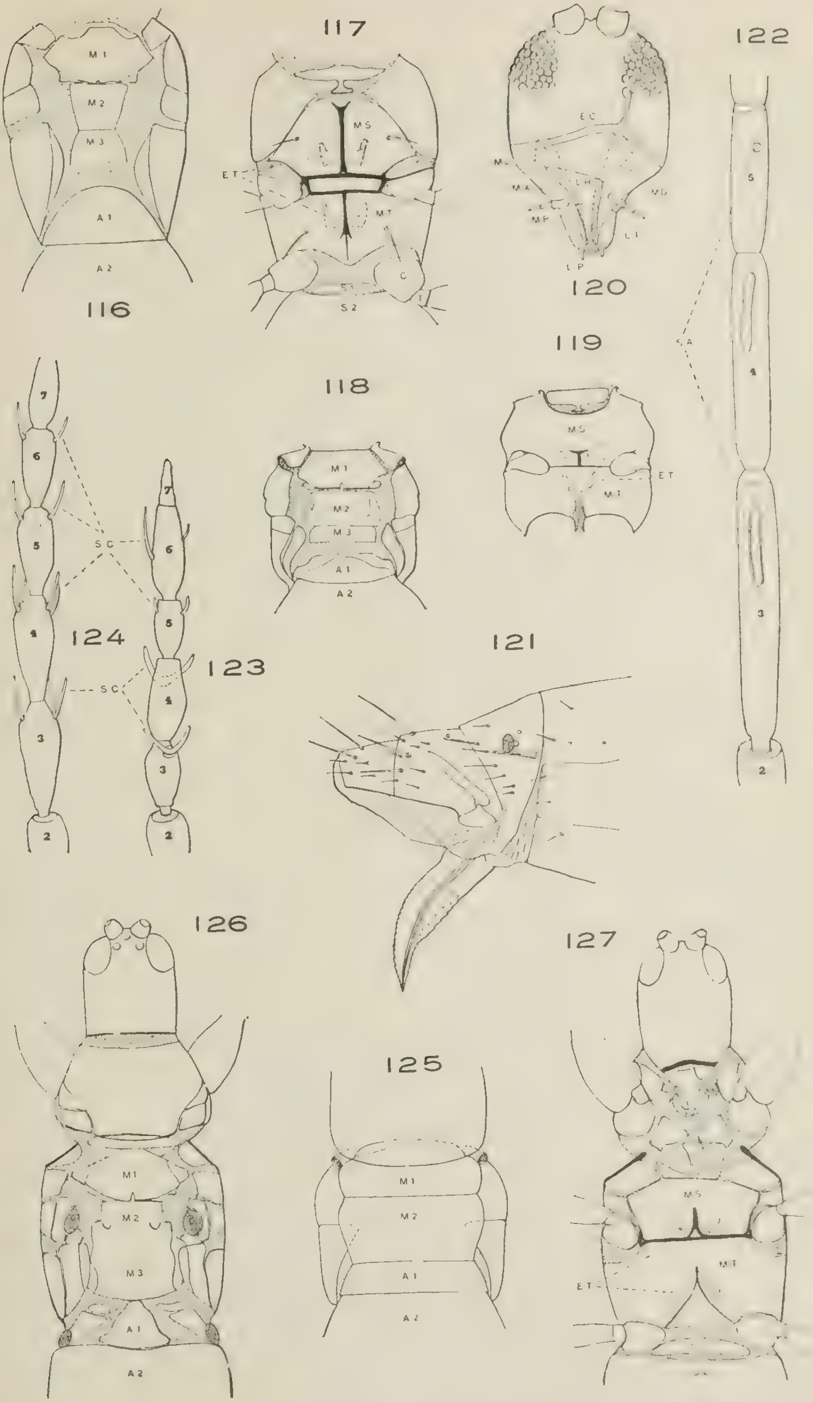

NORTH AMERICAN THYSANOPTERA.

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DESCRIPTIONS OF A NEW GENUS AND FORTY-SIX NEW SPECIES OF CRUSTACEANS OF THE FAMILY GALATHEIDÆ, WITH A LIST OF THE KNOWN MARINE SPECIES.

By James E. Benedict,

Assistant Curator of Marine Invertebrates.

The collection of Galatheids in the United States National Museum, upon which this paper is based, began with the first dredgings of the U. S. Fish Commission steamer *Albatross* in 1883, and has grown as that busy ship has had opportunity to dredge.

During the first period of its work many of the species taken were identical with those found by the U. S. Coast Survey steamer *Blake*, afterwards described by A. Milne-Edwards, and in addition several new species were collected. During the voyage of the *Albatross* to the Pacific Ocean through the Straits of Magellan interesting additions were made to the collection. Since then the greater part of the time spent by the *Albatross* at sea has been in Alaskan waters, where Galatheids do not seem to abound. However, occasional cruises elsewhere have greatly enriched the collection, notably three—one in the Gulf of California, one to the Galapagos Islands, and one to the coast of Japan and southward.

The U. S. National Museum has received a number of specimens from the Museum of Natural History, Paris, and also from the Indian Museum, Calcutta.

The literature of the deep-sea Galatheidæ from the nature of the case is not greatly scattered. The first considerable number of species were described by A. Milne-Edwards from dredgings made by the *Blake* in the West Indian region. Prof. S. I. Smith then described some interesting forms from the U. S. Fish Commission dredgings off the east coast of the United States. This was followed by the report of the Anomura of the voyage of the *Challenger*, by Prof. J. R. Henderson, which contained descriptions of many species of Galatheids from widely separated localities. In 1893 Dr. Faxon published preliminary descriptions of 24 new species from the *Albatross* expedition

to the Galapagos Islands in 1891; also 38 species and subspecies dredged by the Indian survey ship *Investigator* since 1884 have been described by Wood-Mason or by Alcock and Anderson.

Family GALATHEIDÆ.

The Galatheidæ, as has often been pointed out by recent writers, belong to the Macrura Anomalia, but with more or less brachyuran relationships.

In form they resemble the true Macrura, and are closely related to the Porcellanidæ, which at first sight, on account of their form and habits, would be placed with the Brachyura.

Most of the Galatheidæ live on the bottom and, with the exception of a few forms like *Grimothea* and *Pleuroncodes*, probably do not swim freely to any great distance. Some of the genera are blind, inhabiting deep water and even abyssal depths, others again have a well-developed cornea divided into facets. While many Galatheids must prefer a sea bottom affording numerous hiding places, others, as some of the genus *Uroptychus*, are well fitted for climbing on sponges, hydroids, or corals.

Occasionally a specimen will be found with a small worm tube on its carapace, though usually they are as completely free from any foreign growth as are any of the more active Crustacea. More frequently the carapace will be distorted by the presence of an Isopod parasite in the branchial chamber.

This family presents problems in classification of considerable interest. The genus *Munidopsis*, as now constituted and upheld by some good naturalists, is made to include several of the genera established by A. Milne-Edwards. In a long and able article[a] on the subject, A. Milne-Edwards and E. L. Bouvier contend for the generic distinctness of the groups. With the groups united in one genus, the species differ widely in form, more widely than is desirable, because the name does not convey to the mind a sufficiently distinct picture of the forms designated by it. On the other side of the question it may be said that if the genera were divided a satisfactory key could not be made on generic lines unless perhaps in the case of Galathodes.

The species placed in the genus *Munida* come fairly well under one generic name, with the possible exception of one or more species sometimes placed under *Grimothea*, about which much has yet to be learned, especially in regard to the young forms, which do not seem to have the same development as the young of other species. Individual variations within the species are not uncommon. Sometimes the abdomen will be unarmed, where usually it is armed. This is more often true

[a] Considerations Generales sur La Famille des Galatheides, Ann. des Sci. Natr., (7), XVI, p. 191, 1894.

in species having an armature of very small spines, as if chance conditions more easily pushed aside the less emphatic character. In old specimens of some species (and perhaps of all) the spines have a tendency to become blunted or even aborted, the chelipeds to become elongated, and the fingers to be separated by a hiatus. The relative lengths of the supraocular spines are as a rule uniform, and, in connection with others, furnish a very good character. The size and arrangement of the spines of the carapace and also of the abdomen, if armed, are important. Correlated with other characters, the width of the lines of the carapace, the length and character of the cilia, and the size of the granules are of value in determining species.

Some of the species in the U. S. National Museum are represented by but few specimens or even single individuals. In other cases the representation is greater. Large numbers of *Munida iris* A. Milne-Edwards, were taken on the tile-fish grounds during the first year's work of the U. S. Fish Commission steamer *Fish Hawk*. So numerous in fact was this *Munida* that it gave character to the ground. Yet two years later, when the *Albatross* went over the same ground, the hauls of the beam trawl showed that this species, formerly so abundant, was wanting. Three degrees farther south, however, in latitude 37° north, numerous specimens were found.

It will be remembered that the so-called tile-fish (*Lopholatilus chamaeleonticeps* Goode and Bean) was found abundantly during the year 1880, and that some time afterwards a vessel passed through miles of water covered with dead fish of this species. It was not again taken for a long time. The Fish Commission steamer *Albatross* dredged and set trawl lines on the ground time and again without taking either tile-fish or *Munidas;* and even farther south, where the *Munidas* were found in abundance, the fish were not to be had. It is interesting to note that the bottom Crustacea suffered at the same time and probably from the same cause.

Munida refulgens, *M. tenella*, and *M. pusilla*, species with elongated chelipeds, have, like *M. iris*, been found in large numbers, while *M. subrugosa* and *M. quadrispina*, are species with short prismatic chelipeds, and are represented in the collection by a smaller but yet plentiful number of specimens. Some interesting, though by no means novel, deductions may be drawn from the character and environment of some of the genera.

The mass of ova carried by the female *Munida* contains a very large number of individuals in comparison with some genera of the family living in much deeper water. To count the individuals in the egg mass of a *Galathea* or *Munida* would be a long task, while to count those of a *Munidopsis*, *Galacantha*, or *Uroptychus* would be a very easy matter. Some species of *Uroptychus* live in moderate depths that furnish innumerable hiding places. Here there is abundant protection

for the individual. The natural inference is that the young individuals of the species having large eggs and few in number, do not encounter the dangers which must be common to the species having numerous eggs, and, as a matter of fact, it can hardly be supposed that a *Galacantha* or a *Munidopsis*, blind and with limited activity, passes an eventful life on the soft bottom of the deep sea.

Another matter worthy of consideration is that where the brood is small and matures near the parent it is not liable afterwards to become greatly scattered, a fact which would be expected to aid in the formation of races and species in the same way that it is known to have done in the cases of nonmigrating birds inhabiting islands or other isolated localities. And here it may be remarked that little is known of the range of any species in the deep sea. Only a beginning has been made. A dredging station here and there shows a few of the forms of life which the dredge chances to bring up from a very limited area. Until the sea bottom has been examined to a very much greater extent it would seem better to hold that distinguishable specimens from distant places represent distinct species rather than subspecies.

In sharp contrast with those Crustaceans which have few eggs and live under conditions where the individual must be better cared for are those having an immense number of eggs, as, for instance, some of the shallow-water Brachyura, in which the bulging egg-mass is but partly covered by the abdomen, and nearly equals the body of the crab in size. Here the eggs are minute and when hatched become free swimming and are carried by the currents to distant places to live or die, as the place proves suitable or not. This effort of nature is paralleled by the forest tree which yields seed, season after season, during a long lifetime and perhaps dies without leaving a single descendant. But if this effort has not greatly increased the individuals of the species in question, it has always been ready to do so if opportunity offered, and in the meantime has helped to sustain the life of myriads of other living things.

In this paper 45 species are described as new. The keys to the species were made to include all the Galatheids in the U. S. National Museum. Following the descriptions a list of the known species, with partial synonymy, has been given.

DESCRIPTIONS OF NEW SPECIES.

Genus GALATHEA Fabricius.

KEY TO THE SPECIES OF GALATHEA EXAMINED.

a. With only two spines or tubercles on the front of the gastric area.
  b. Hands without spines except on the margins................*squamifera*, p. 303
  b. Hands with spines on the palm.
    c. Three pairs of spines on the rostrum beyond the basal pair.
      d. Row of four or five spines on the palm.
        e. Palm wide..*strigosa*, p. 303

e. Palm narrow.

f. Spines of rostrum weak ....*andrewsi*, p. 300

f. Spines of rostrum strong..*intermedia*, p. 302

d. Row of nine or ten spines on the palm of the hand.........*orientalis*, p. 302

c. Two pairs of spines on the rostrum beyond the basal pair.*californiensis*, p. 247

a. With more than two spines or spinules on the front of the gastric area or none.

b. With a row of spinules on the front of the gastric area.

c. Rostrum entire beyond the basal spines ....*integra*, p. 248

c. Rostrum armed.

d. Lines on the carapace strong, elevated, few ....*rostrata*, p. 303

d. Lines but little elevated, more numerous.................*intermedia*, p. 302

b. Without a row of spinules on the front of the gastric area.

c. Spines on the rostrum weak or none.

d. No spines on the rostrum beyond the basal pair.............*agassizi*, p. 300

d. With spines on the rostrum beyond the basal pair......*paucilineata*, p. 249

c. Spines on the rostrum large...................*dispersa and nexa*, pp. 301, 302

GALATHEA CALIFORNIENSIS, new species.

The rostrum is more than twice as long as the eyes. It is armed with two pairs of stout spines. The sides of the rostrum are parallel

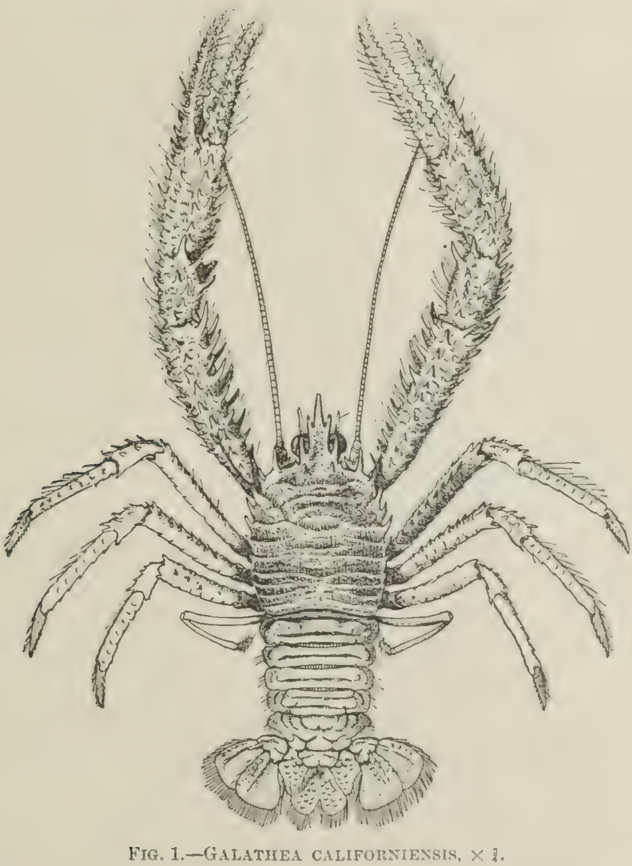

FIG. 1.—GALATHEA CALIFORNIENSIS, × ¾.

between the spines. At the angle formed by the base of the rostrum and the front there is a pair of small spines. The carapace lacks but little of being as broad as long; the transverse ridges are elevated and

slightly set with hair. There are six spines on the margin behind the antennal spine. On the gastric region there is a pair of spines directly behind the posterior pair on the rostrum. The chelipeds are long and stout, very spiny and moderately hairy; the merus has five rows of spines; the carpus has three rows on its inner surface and four rows on its upper and outer surfaces; the outer surface of the palm has three rows of spines which are continuous with rows on the merus and carpus. The merus and carpus of the ambulatory legs are spiny; there is one row on the crest of the merus and two on the carpus; the propodus and dactyl are scabrus. The merus of the maxillipeds is armed with one long stout spine and one short one.

Length of a large male from the front to the end of the telson, 61 mm.; length of cheliped, 100 mm.; length of merus, 38 mm.

Locality.—*Albatross* station[a] 2946, lat. 33° 58′ N.; long. 119° 30′ 45″ W.; depth, 150 fathoms.

Type.—Cat. No. 20551, U. S. N. M.

GALATHEA INTEGRA, new species.

To the eye the rostrum is entire from the spine-like point to the spine which forms the inner angle of the orbit; under a lens the lateral margins are seen to end in spinules at about one-sixth of the distance from the apex to the cornea; beyond these spinules the rostrum is spine like in shape; behind the spinules the margins run divergently back to a point opposite the spines which form the inner angles of the eyes, where the direction is changed to parallel; the portion of the rostrum between the eyes is excavated in the form of a very open V.

The outer angles of the orbits are guarded by spines. A little behind and to one side of these spines are the smaller spines of the antero-lateral angles.

The carapace is armed on the gastric region with four spines placed in a transverse row. Between this row of spines and the posterior margin the median line cuts six long raised transverse lines. In addition there are more or less short, intermediate lines. The spines of the lateral margin, six or seven in number, are fragile, often wanting.

The merus of the maxillipeds is armed with a single large spine.

The chelipeds are elongated, in large specimens, with widely gaping fingers; the merus is sparsely set with short, stout spines; the carpus has a row of four spines on its upper surface and a row of five or six on the inner margin, but its most prominent armature is a single very large spine a little below the inner row. Three rows of spines arm the palm; those of the crest are the largest and most numerous.

Length of carapace, including rostrum, 7.5 mm.; length of cheli-

[a] A complete list of the dredging stations of the U. S. Fish Commission steamer *Albatross*, compiled by Mr. C. H. Townsend, will be found in U. S. Fish Commission Report for 1900, pp. 393–419.

peds, 30 mm. Taken from numerous stations off Honshu Island, Japan; the types are from *Albatross* station 3708, in 60 to 70 fathoms.

Type.—Cat. No. 26168, U.S.N.M.

Galathea integrarostris Dana, resembles this species. It has a rostrum with margins unbroken by spines, but much shorter and broader in proportion to its other measurements. If Dana's figure is correct, the inner angle of the orbital sulcus is shaped by an incision of the rostrum which forms a broad tooth, which can not possibly be confounded with the sharp slender spine of *G. integra*.

GALATHEA PAUCILINEATA, new species.

The rostrum is rather narrow, with a few small spines on the sides; at the angle of the front and rostrum there are two short paired spines, which stand out well from the margin; those of the rostrum proper lie closely along the margin. On the front, above the insertion of the antennæ, there is a small paired spine; the antero lateral angle is rounded; there are five or six spinules on the lateral margin.

FIG. 2.—GALATHEA PAUCILINEATA, × 3½.

The raised lines that cross the carapace are widely separated and little ciliated. The merus of the maxillipeds is armed with a single long and slender spine. The ambulatory feet are slightly spinulose on the crests of the meral and carpal joints.

Length of the carapace, 6 mm.; breadth, 5.5 mm.

Type.—Cat. No. 20552, U.S.N.M.

Locality.—*Albatross* station 2818, latitude 00° 29′ 00″ S., longitude 89° 54′ 30″ W., in 392 fathoms.

CERVIMUNIDA, new genus.

Like Munida, but with a compressed rostrum which is arched so as to permit free movement of the eyes, and bears large teeth.

CERVIMUNIDA PRINCEPS, new species.

The rostrum in this species is armed with three sharp triangular teeth, two on the upper margin in advance of the eyes and one below and in advance of the upper ones; in addition to this armature one or

more spinules are usually found between the apex and the two teeth above.

The direction of the rostrum is horizontal but opposite the eyes it forms an arch, resuming its horizontal direction beyond. In cross section the rostrum is triangular with the short side below, the lower margins are carinate, the carina running around to the supra-ocular spines; the length of the rostrum from the tip to the base of the free portion of the supra-ocular spines is equal to the distance from the latter point to the posterior margin of the gastric region.

The supra-ocular spines reach the middle of the eyes; their free portions are equal in length to the antero-lateral spines.

The gastric pair of spines are large and sharp with no intermediate armature; in line outside is a small paired spine and in some specimens a second much smaller one; an unusual spine in the gastric area is at the intersection of the first ciliated line with the median line of the carapace; the usual spines occur at the extremities of the ciliated line.

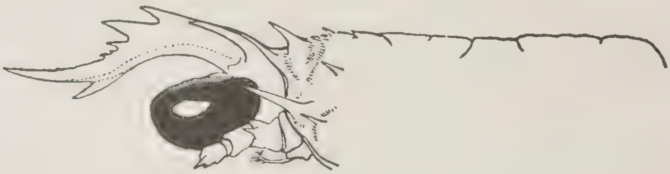

FIG. 3.—CERVIMUNIDA PRINCEPS. × 2.

There is a single paired spine in the fork of the suture and one in the usual place just behind the suture. The lower margin of the merus of the maxillipeds has a spine at each extremity.

The chelipeds are elongated; spines are scattered over the merus and carpus; the fingers are longer than the ridge of the palm; the movable finger is armed with a row of spines on the inner surface just below the ridge; numerous small spines are scattered over all surfaces of the palm, except the lower; the chelipeds are hairy in the large specimens; the ambulatory legs are squamose and hairy.

The abdomen is armed. The 12 specimens examined show for the most part eight spines on the second and fourth segments; the third segment shows six, seven, or eight spines, but usually six; in the other segments the number of spines also varies but not so frequently.

The length of the largest specimen examined is 147 mm., carapace, from the base of the rostrum, 27 mm.; chelipeds, 102 mm.

Type.—Cat. No. 25464, U.S.N.M., from *Albatross* station 3698, in 153 fathoms off Honshu Island, Japan.

Genus MUNIDA Leach.

KEY TO THE SPECIES OF THE GENUS MUNIDA EXAMINED.

1. Abdomen unarmed.
    a. Rostrum with several lateral spines near the apex .... *refulgens*, p. 312
    a. Rostrum without spines at apex.
        b. Palm much shorter than the fingers .... *mexicana*, p. 264
        b. Palm ranging from a trifle shorter to much longer than the fingers.
            c. Palm and fingers subcylindrical.
                d. No spines posterior to the middle transverse depression .. *simplex*, p. 272
                d. With spines posterior to the middle of the transverse depression.
                    e. Supraocular spines not reaching the middle of the eyes . *debilis*, p. 256
                    e. Supraocular spines reaching the middle of the eye ...... *irrasa*, p. 310
            c. Palm and fingers flattened.
                d. With several spines posterior to the middle transverse depression .... *sculpta*, p. 270
                d. No spines posterior to the middle depression .... *quadrispina*, p. 269
2. Second segment of the abdomen armed.
    a. Chelipeds more than four times the length of the carapace, including the rostrum; palms subcylindrical, armed with but few spinules.
        b. Supraocular spines, reaching nearly to the distal margin of the cornea. *iris*, p. 310
        b. Supraocular spines, short, not reaching the cornea .... *pusilla*, p. 268
    a. Chelipeds less than four times the length of the carapace.
        b. Gastric spines, with two or three small intermediate spines.
            c. Cornea but little larger than the peduncle.
                d. Merus of maxillipeds armed with one spine .... *perlata*, p. 266
                d. Merus armed with two spines .... *microphthalma*, p. 311
            c. Cornea wide, spreading; much larger than the peduncle.
                d. No spines on the margins of the fingers.
                    e. Fingers three times length of palm .... *curvamana*, p. 307
                    e. Fingers not three times the length of palm.
                        f. Rostrum cutlass-shaped, elevated to an angle of 45 degrees above line of carapace .... *curvatura*, p. 253
                        f. Rostrum sigmoid, horizontal .... *andamanica*, p. 306
                d. With spines on the margins of the fingers.
                    e. Supraocular spines, reaching beyond the eyes ...... *propinqua*, p. 312
                    e. Supraocular spines not reaching beyond the eyes.
                        f. Fingers straight.
                            g. Spines in the gastric row, six.
                                h. One spine in the triangular area .... *sancti-pauli*, p. 312
                                h. No spines in the triangular area .... *decora*, p. 257
                            g. Spines in the gastric row, twelve .... *honshuensis*, p. 261
                        f. Fingers curved .... *curvipes*, p. 254
        b. No intermediate spines.
            c. Fingers much longer than the palm .... *forceps*, p. 307
            c. Fingers shorter than the palm.
                d. Hand bent downward at the base of the fingers, all surfaces spinulose .... *angulata*, p. 252
                d. Hand not bent, broad, spinulose on outer surface and margins. *nuda*, p. 265
3. Second and third segments of the abdomen armed.
    a. A pair of spines between the large gastric pair.
        b. Without spines behind the cervical suture. (See 2 above) ... *decora*, p. 257
        b. With spines behind the cervical suture .... *obesa*, p. 311

a. Without spines between the large gastric pair.
b. With a pair of spines near the middle of the gastric region ---- *valida*, p. 314
b. Without middle gastric spines ---- *media*, p. 262
4. Second, third, and fourth segments of the abdomen armed.
a. Posterior margin of the carapace armed.[a]
b. Spines of the posterior margin more than two.
c. With spines on the cardiac region.
d. Cardiac spines one only ---- *evermanni*, p. 307
d. Cardiac spines more than one.
e. Cardiac spines one pair ---- *perarmata*, p. 311
e. Cardiac spines in two rows ---- *hispida*, p. 259
c. Without spines on the cardiac region ---- *bamffica*, p. 306
b. Spines on the posterior margin one or two.
c. Fourth segment of the abdomen with a pair of spines on the anterior margin and a single spine on the median line near the posterior margin.
d. Spines on the middle of the gastric region one or more.
e. Supraocular spines longer than eyes ---- *affinis*, p. 305
e. Supraocular spines shorter than eyes ---- *flinti*, p. 258
d. Without spines in the middle of the gastric region.
e. With a row of spines on each side of the cardiac region ---- *normani*, p. 311
e. Without rows of spines on the branchial region near the cardiac region ---- *prolixa*, p. 313
c. Fourth segment of the abdomen without median spine.
d. Supraocular spines longer than the rostral spine ---- *longipes*, p. 310
d. Supraocular spines not longer than the rostral spine ---- *stimpsoni*, p. 313
a. Posterior margin of the carapace unarmed.
b. Chelipeds long and slender; merus cylindrical ---- *tenella*, p. 274
b. Chelipeds short and stout; merus prismatic.
c. Two or more spines on the outer margins of both fingers of the chelipeds ---- *constricta*, p. 307
c. No spines on the outer margins of the fingers.
d. Merus of the maxillipeds unarmed.
e. Eyes produced beyond the line of the sides ---- *gregaria*, *young*, p. 308
e. Eyes not produced beyond the line of the sides ---- *gregaria*, p. 308
d. Merus of the maxillipeds armed ---- *subrugosa*, p. 314

MUNIDA ANGULATA, new species.

The carapace is broadest a little behind the middle. The gastric region has eight spines, six of which are in a line behind the front. These spines are subequal in size. A single spine is placed on the side near the margin of the hepatic area; single spines on the anterior branchial regions are the only other spines on the carapace, excepting those of the lateral margins. The supraocular spines are about one-half the length of the eyes. The rostrum is moderately long and nearly horizontal. The peduncles of the eyes are stout and a little longer than usual; the cornea is less dilated. The front retreats from the eye spines. The inferior margin of the merus of the maxillipeds is armed with two spines. The chelipeds are spiny and spinulose; the fingers are cylindrical and in all specimens examined are in contact

[a] Occasional specimens found with posterior margin of carapace unarmed.

throughout the length of their prehensile edges. A striking character of this species is the shape of the hand, which is bent downward from the base of the fingers. A row of from two to six spinules arms the second segment of the abdomen; in some specimens the armature is wanting.

Length of the abdomen, 9 mm.; length of chelipeds, 20 mm.; length of palm, 5.5 mm.; length of fingers, 4 mm.

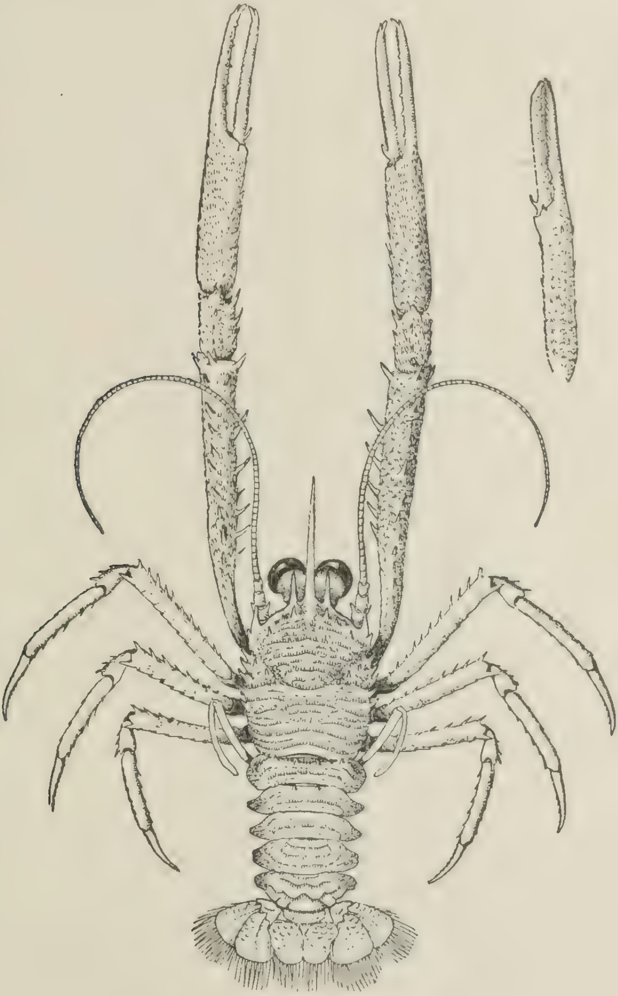

FIG. 4.—MUNIDA ANGULATA, × 4.

Locality.—*Albatross* stations 2370, 2372, 2406, 2411, 2413, in 25, 27, 26, 27, and 24 fathoms.

Type.—Cat. No. 20532, U.S.N.M., station 2406.

MUNIDA CURVATURA, new species.

The rostrum is long, sharp, and a little compressed, beginning at its base it curves rapidly upward, so that at its tip its direction is 45 degrees from the line of the carapace. The supraocular spines

diverge but little, they extend forward nearly to the extremity of the eyes.

The eyes are large with a brown iris, which has small, but distinct facets.

The carapace is broadest at about the anterior third, the gastric pair of spines are large, a pair of much smaller spines are intermediate, outside of the pair is a paired spine, equal to the intermediate spines in size; outside of this are one or more very small ones; at the extremities of the first ciliated line are the only other spines on the surface of the carapace, with the exception of two spinules behind the fork of the cervical suture. The ciliated ridges are rather coarse; between the ridges are lines having short cilia.

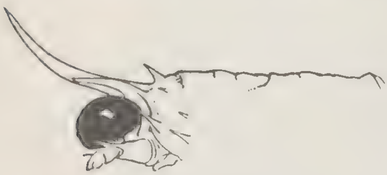

FIG. 5.—MUNIDA CURVATURA, × 2.

The merus of the maxillipeds is armed with two well-separated spines.

The chelipeds are short and stout, the spines of the distal extremities of both merus and carpus are unusually large. The palms have three rows of spines on the outer surface, there are no spines on the margins of the fingers. The distal extremities of the merus of the ambulatory legs are very large.

The second segment of the abdomen is armed with eight good-sized spines.

The length of the carapace from the base of the rostrum is 17 mm.; length of rostrum 9 mm.; length of chelipeds 40 mm.

Locality.—From *Albatross* station 3698, off Honshu Island, Japan, 153 fathoms.

Type.—Cat. No. 25466, U.S.N.M.

MUNIDA CURVIPES, new species.

The carapace is broadest in the middle; it is crossed by numerous striae which are strongly setose. The gastric region is armed with six spines, those of the gastric pair are much the largest; two paired spines at the side make up the six; the one nearest the side is opposite the second spine on the margin, or the one next behind the antero-lateral spine. Between the gastric spines are three granules, one of which has a sharp point to be seen only with a lens. Three spiny granules are situated close to and behind the gastric pair. The greater part of the rostrum is unfortunately lost; the supraocular spines reach the end of the cornea. The peduncle of the antennae is armed as in *Munida spinosa* Henderson, with the exception of the terminal article where the spine is so small that it can not be made out except under a lens. The eyes are much smaller than in many species of the genus. The merus of the maxillipeds is armed with two long spines; the margin

between them is straight and not at all as shown in the figure of *M. spinosa*. The chelipeds are long and rather slender, armed with slender spines placed for the most part in rows; there are about eighteen spines on the merus, large and small; the carpus has at least an equal number; there are four rows of spines on the palm; the fingers of the left hand are unarmed; those of the right are both armed.

The second segment of the abdomen is armed with six spines, which nearly equal the gastric pair in size; the other segments of the abdomen are smooth.

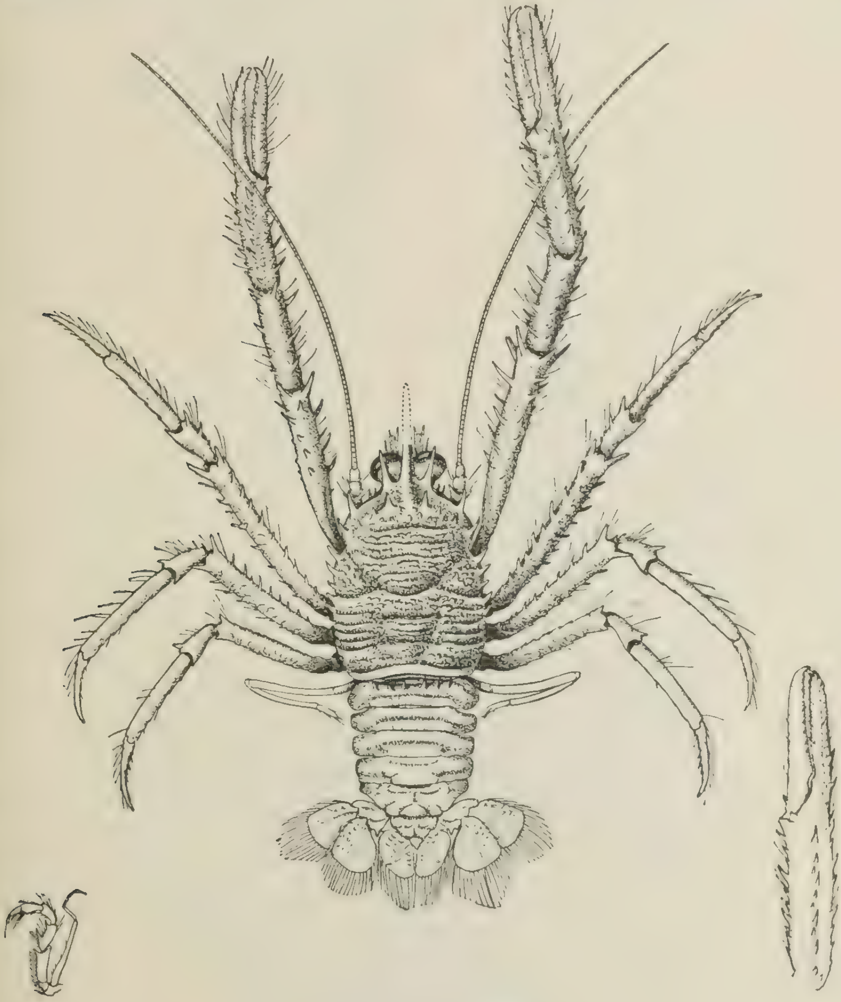

Fig. 6.—Munida curvipes, × 1¾.

This species is closely related to *Munida spinosa* Henderson. It is separated by the lines of the carapace, which are not so strong, by the different shape of the pleura of the abdominal segments, and if the *Challenger* figure is correct, the merus of the maxillipeds is very different.[a]

[a]Challenger Report, Anomura, J. R. Henderson, XXVII, 1888, p. 128, pl. III, fig. 3, a, b.

Measurements. Length of specimen from the base of the free part of the rostrum to the end of the telson 30 mm.; length of the cheliped 40 mm.; palm 10 mm.; fingers, 8 mm.

Locality.—*Albatross* station 2788, off Port Otway, Patagonia, in 1,050 fathoms.

Type.—Cat. No. 20533, U.S.N.M.

MUNIDA DEBILIS, new species.

The carapace is broad in front; the spines of the antero-lateral angles are longer than the free portion of the supraocular spines.

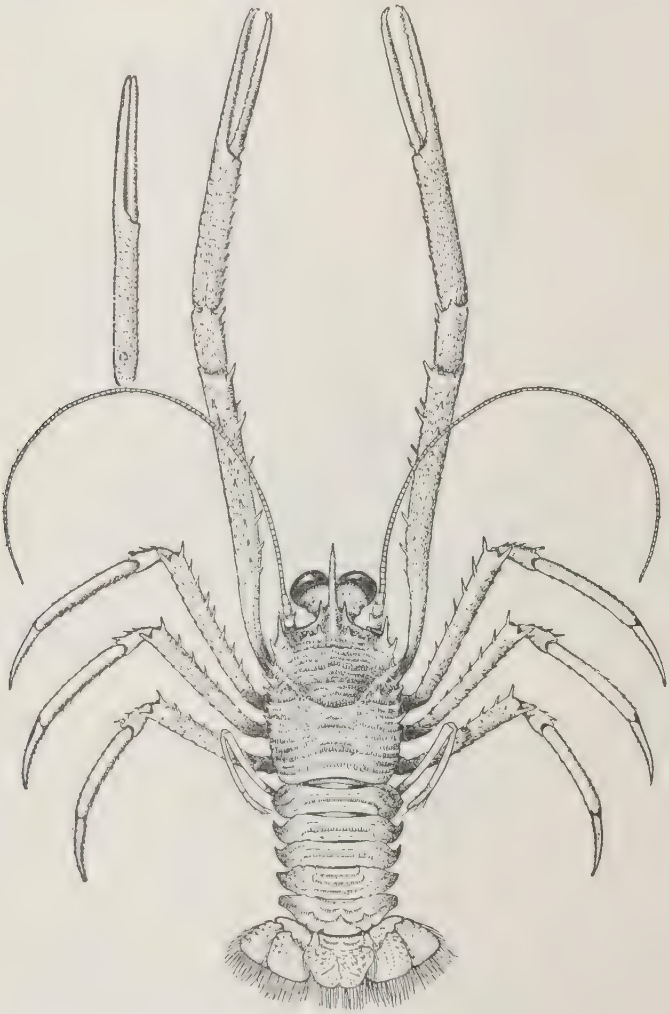

FIG. 7.—MUNIDA DEBILIS, × 4.

There is a row of eight spines on the front of the gastric area and a spine at the extremities of the first continuous ciliated line. Between this line and the gastric row is a ciliated line interrupted at the median line by a semicircle of the same character.

The rostrum is long and slender; the lateral margins are denticulated near the apex; the supraocular spines are united to the rostrum for one half their length. The peduncles of the eyes are short and the cornea very much dilated. The inferior margin of the merus of the maxillipeds is armed with three spines, two on the proximal half and one on the distal angle. The chelipeds are long, slender, cylindrical, and scabrous; the inner margin of the merus is armed with about six large spines; there are three on the upper surface; the carpus has a single large spine at the distal inner angle. This species is easily distinguished from any other described species from the West Coast by its slender elongated cheliped in connection with the unarmed abdomen.

Locality.—*Albatross* station 2829, lat. 22° 52′ 00″ N., long. 109° 55′ 00″ W., in 31 fathoms.

Type.—Cat. No. 20534, U.S.N.M.

MUNIDA DECORA, new species.

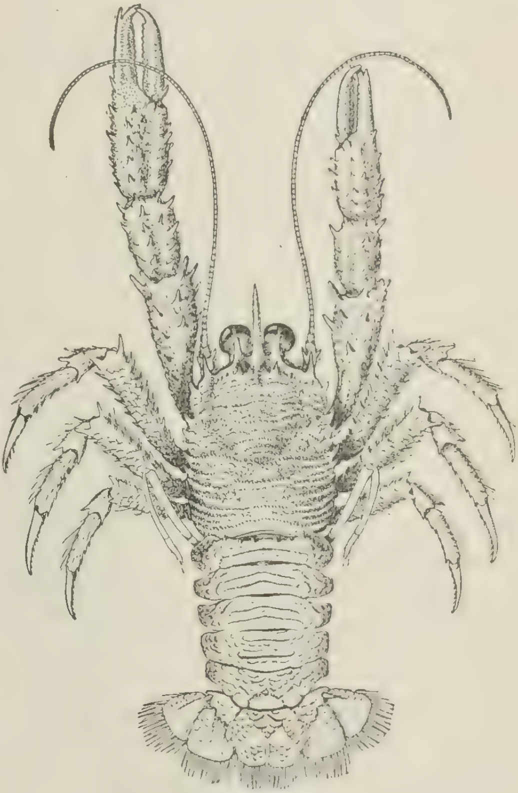

FIG. 8.—MUNIDA DECORA, × 1½.

The carapace is crossed by six continuous ciliated and granulose lines; between these lines are numerous other lines of the same character, but broken into small arcs, which are arranged in beautiful patterns. The carapace is nearly devoid of spines; there are two on the gastric area in the usual place, with several spinules in line between and at the sides; posterior to this row there are no spines on the surface. The marginal spines are small. The supraocular spines diverge and reach nearly to the extremities of the eyes. The rostrum is strong—about twice as strong as the supraoculars—and is serrate near the end, above and below, and on the sides. The peduncles of the eyes are very short and much constricted; the cornea is dilated at the sides. The inferior margin of the merus of the maxillipeds is armed with two large and widely separated spines, between which are one or more spinules.

The chelipeds are broad, flattened, and hairy. The spines of the

distal margin of the merus are large; those of the carpus are smaller. There are four rows of spines on the palm—one on each margin and two on the surface behind the gape of the fingers; there are also two spines on the crest of the palm, in a parallel line with the marginal row; a single spine is placed near the middle of the inside of the palm; the inside surface is roughened by numerous spiny granules.

The ambulatory feet are compressed and moderately spinose. The abdomen has a line of spines on the second segment.

The specimen described is a female measuring 33 mm. from the front to the end of the telson; length of larger cheliped, 39 mm.; length of palm, 7 mm.; length of fingers, 7 mm.

Locality.—South of Cuba; *Albatross* station 2133. Lat. 19° 55′ 55″ N.; Long. 75° 48′ 03″ W. In 290 fathoms; eight specimens, one large and seven small.

Type.—Cat. No. 7810, U.S.N.M.

One of the largest of the small specimens measures 17 mm. in length. They differ from the large one taken for the type in having but one row of spines on the outside of the palm and several in having the third segment of the abdomen armed with only two spines. The supraocular spines are shorter.

MUNIDA FLINTI, new species.

The rostrum usually extends beyond the eyes about one-half of its length. The supraocular spines are shorter than the eyes, both the rostrum and the supraoculars are smoother than in *M. affinis.* As in that species the normal number of spines on the gastric area is seven, the middle spine, however, is often wanting, the other spines of the carapace are the same as in *affinis.* The tranverse lines and the granules are not crowded as in *affinis,* and the cilia do not reach from line to line.

The armature of the abdomen is the same as in *affinis* except in the lateral spines, which number two on each side of the central pair on the second segment and but one on the third segment, while the fourth segment has only the central pair and a single posterior spine on the median line. The chelipeds are scabrous and spiny; the merus has about fourteen spines on or near the crest, and here and there a single spine on other parts of the surface. The palm of the hand is densely scabrous, the spinules are few and scattered. The dactyl has a row of widely separated spinules on its margin. The prehensile edges of the fingers are set with hair and armed with well separated teeth; between the teeth the edge is crowded with denticles.

This species is much like *affinis* and *stimpsoni* in general appearance, but very different from either in detail. Named for Dr. J. M.

Flint, U. S. Navy, surgeon on the U. S. Fish Commission steamer *Albatross*.

All the specimens were taken by the *Albatross* during a cruise in the northern part of the Gulf of Mexico.

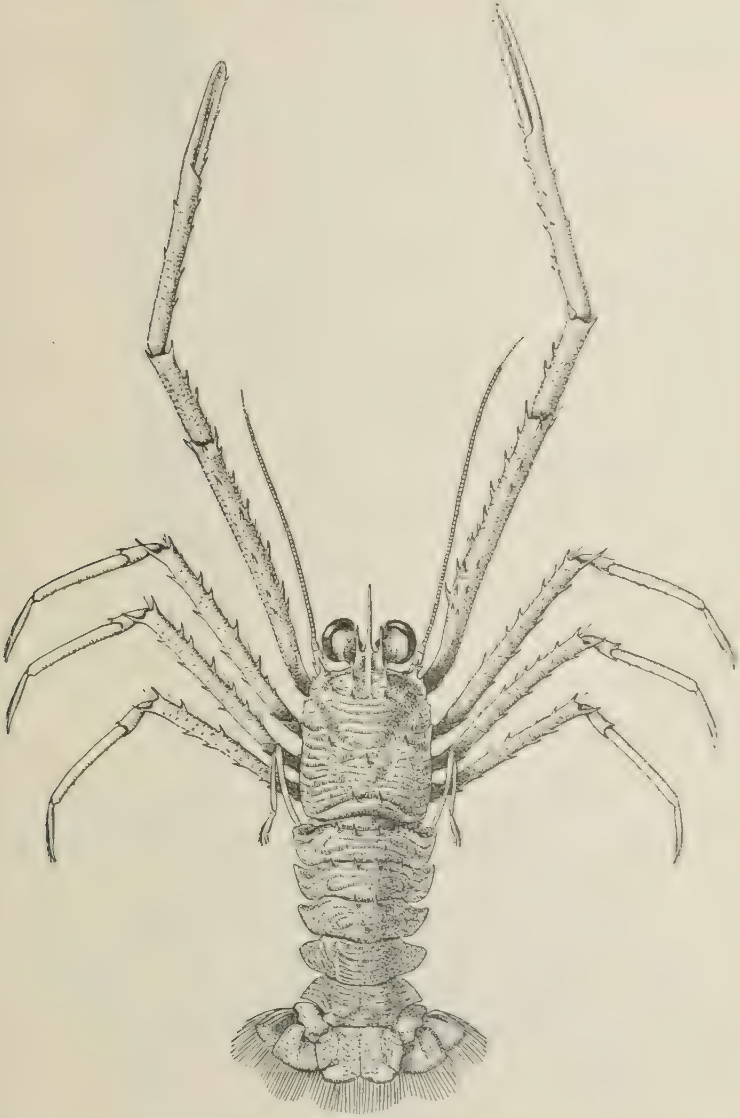

FIG. 9.—MUNIDA FLINTI, × 2.

Locality.—*Albatross* station 2402 in 111 fathoms, two specimens; station 2403 in 88 fathoms; station 2404 in 60 fathoms, eleven specimens.

Type—Cat. No. 9778, U.S.N.M.

MUNIDA HISPIDA, new species.

The carapace is broadest at about the posterior third; the breadth at the posterior margin is greater than the front. The front is flattened, almost transverse between the supraocular spines and the

spine behind the antennæ. The transverse lines are strong, granulose, and sometimes spinulose.

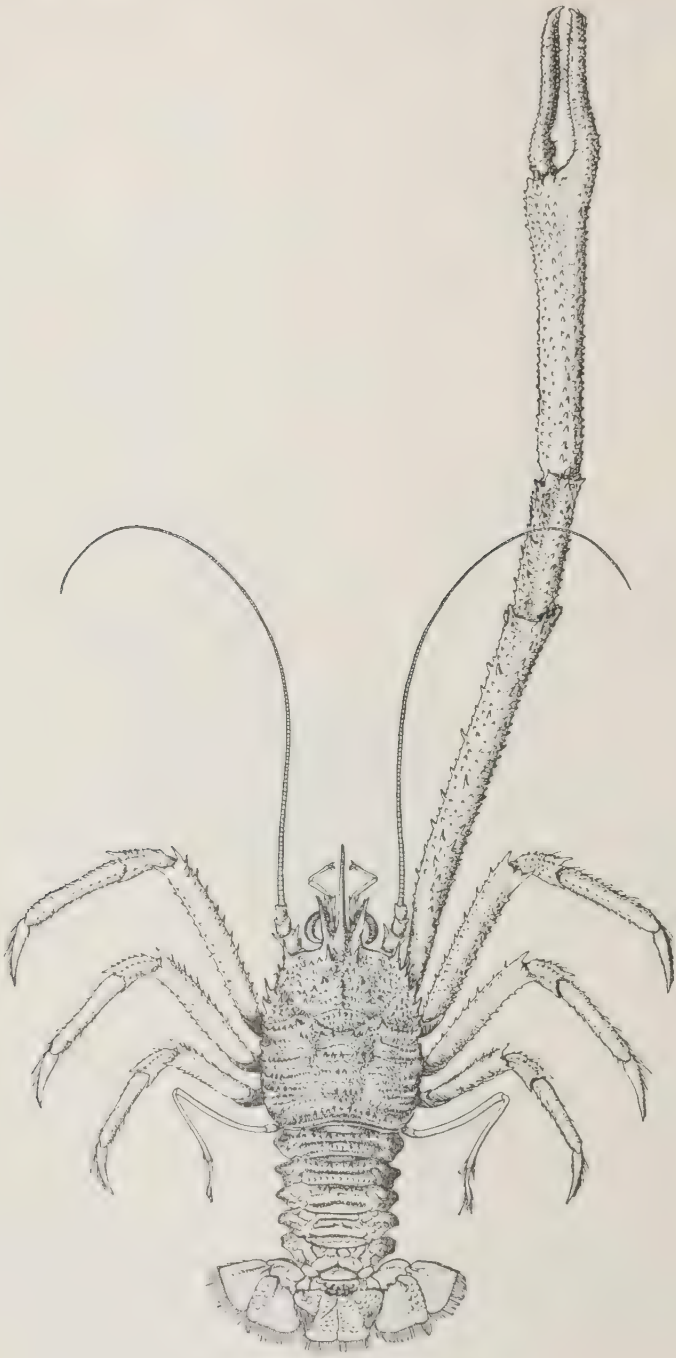

FIG. 10.—MUNIDA HISPIDA, × $\frac{3}{5}$.

The gastric spines are small; a much smaller pair is placed in advance and a little closer together. On the median line of the gastric region there are five or six spines, and on a ridge behind these there is a row

of spinules; at the side there are two spines obliquely placed; a number of spinules are scattered over the anterior portion and sides of this area. There are about sixteen spinules on the triangular area; a spine on the branchial area just behind the apex of the triangle, and another paired spine just behind this. The posterior border of the carapace has an armature of low spines about eighteen in number in the figured specimen, and about ten in the smaller ones; the spines of the lateral margin number from seven to ten.

The rostrum is more than twice as long as the supraocular spines; it is slightly sigmoid and minutely serrate. The supraocular spines are a little longer than the eyes, are stout at the base and taper rapidly to a sharp point. The merus of the maxillipeds is armed on its inferior margin with two spines, which are widely separated. The chelipeds are stout, prismatic, and spinose. The merus of the ambulatory feet is triangular in cross section; both upper and lower anterior margins are thickly set with short curved spines.

The second, third, and fourth segments of the abdomen are armed, the second and third with two rows of spines and the fourth with a single row; the second row of the double rows is composed of smaller spines, and in all but the largest specimens these are usually wanting.

Length of the type from the extremities of the rostrum and telson, 83 mm.; length of right cheliped, 186 mm.; merus, 70 mm.; palm, 53 mm.; fingers, 30 mm.

Locality.—*Albatross* station 2817, Galapagos Islands; *Albatross* station 2987. Off Lower California seven specimens much smaller than the type.

Type.—Cat. No. 20535, U.S.N.M.

The variation between the large specimen taken for the type and the smaller specimens is considerable. The carapace of the smaller ones lack many of the spinules, and the spines are larger; the fourth segment of the abdomen may show only two small protuberances in place of the row of spines. The chelipeds are much shorter, and they are armed with definite rows of spines; the palm is prismatic, and the prehensile edges of the fingers are in contact throughout. The rostrum in some of the smallest is slightly bent upward. With all this variation, however, the specimens intergrade, and in my opinion give no ground for separation.

MUNIDA HONSHUENSIS, new species.

The rostrum is slightly sigmoid, and is more than twice the length of the supraocular spines, which do not quite reach the cornea.

The spines of the gastric area are sixteen in number—twelve in the gastric row, a pair separated by the first ciliated line, and a paired spine at the base of the antero-lateral spine; there is a single paired spine in the fork of the cervical suture and one back of the fork.

The spines of the merus of the maxillipeds are large and situated at the extremes of the segment.

The chelipeds are short, stout, and prismatic; the spines of the distal portion of the merus are very large, becoming smaller proximally.

There are four rows of spines on the carpus. The largest occupy the crest, the smallest the row on the outer surface near the lower margin. Medium sized spines occupy the rows that arm the inner and outer surfaces. The outer margins of the fingers are each armed with four rather large spines.

The second segment of the abdomen is armed with nine spines, which are short and blunt.

The length of the carapace from the end of the rostrum is 16 mm.; length of chelipeds, 26 mm.

One specimen, female, from *Albatross*, station 3708, in 60 to 70 fathoms, off Honshu Island, Japan.

Type.—Cat. No. 25472, U.S.N.M.

FIG. 11.—MUNIDA HONSHUENSIS, × 2¼.

This species is an addition to the group of which *Munida militaris* Henderson is the typical example. It differs in not having spines on the median line of the carapace and in its shorter and less divergent supraoculars.

The hands of this species are compressed, the outline of the palms is straight, and not as shown in the figure of *M. militaris* in the *Challenger* report; the outer surface of the palms is made up of two planes which intersect at the median row of spines.

Two males were taken at station 3739 in 55 to 65 fathoms, which differ from the specimen taken as the type in that the chelipeds are elongated, and are without any prominent spines, there are numerous small spines on the merus and carpus, a few on the palm, and one or two on the margins of the fingers. There is a hiatus between the fingers, the prehensile edges of which are set with small teeth even in size and with rounded ends; the hiatus which extends the length of the fingers is filled with bristles which arise from the lower surface of both fingers.

MUNIDA MEDIA, new species.

The carapace is widest in the middle; the sides are arcuate, the anterior portion is armed with six or seven spinules.

The transverse striæ are not crowded; are both granulated and ciliated; the cilia are iridescent. The postocular or gastric spines are small; a much smaller paired spine stands at the side in line with them; another paired spine is placed farther down near the hepatic region. The cervical groove is deep; where it meets the side there is a notch; the cilia in both branches are longer than elsewhere. The triangular

areolation in the fork of the groove is armed with five or six spinules. There are also several spinules on the anterior border of the branchial region. The posterior border of the carapace is unarmed.

The rostrum is slender and elongated, equaling in length the width of the carapace; the supraocular spines are short, not reaching the distal extremity of the cornea. The inferior border of the merus of maxillipeds is armed with three slender spines graded in size, the proximal being the longest.

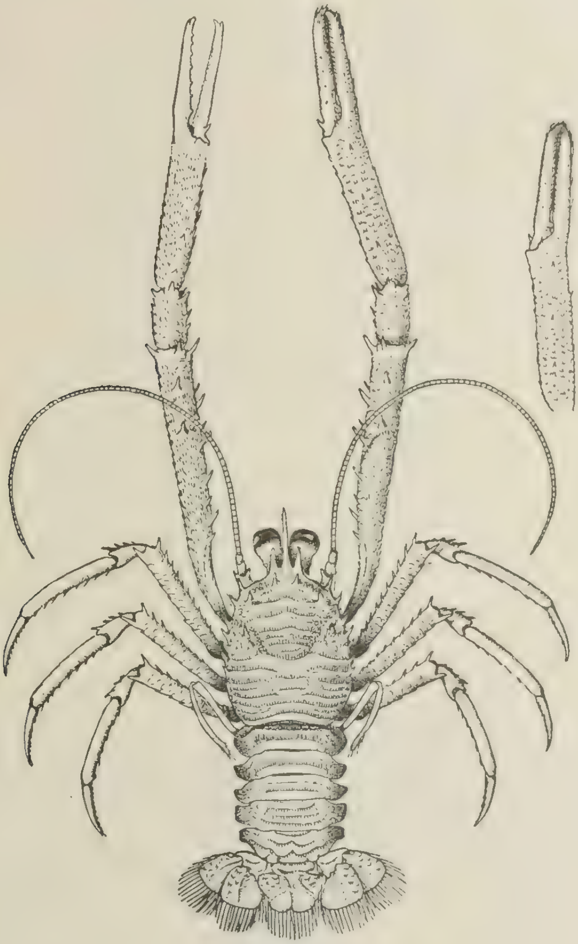

FIG. 12.—MUNIDA MEDIA, × 4.

The eyes are large with spreading cornea.

The chelipeds are long, slender, and subcylindrical; the merus and carpus are armed with slender spines, the palm with spinules.

The merus of the ambulatory legs has a row of spines on the upper margin; in line with these there are five or six on the carpus; the lower margin of the propodus has a row of seven spinules.

The second segment of the abdomen has a row of eight small spines and the third segment a single pair. The other segments are smooth.

The length of the body from the front to the end of the telson is 10 mm.; length of the chelipeds, 24 mm.; length of the palm, 5 mm.; length of the fingers, 4.3 mm.

Locality.—Off Habana, *Albatross* station 2343, 279 fathoms.

Type.—Cat. No. 9524, U.S.N.M.

MUNIDA MEXICANA, new species

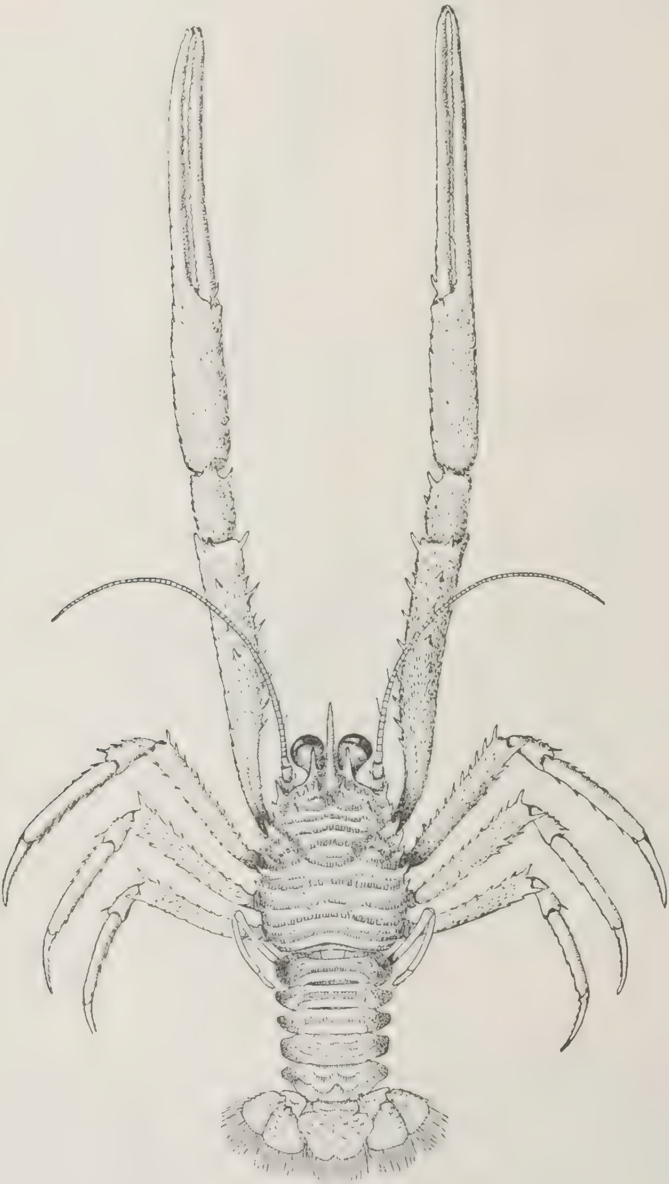

FIG. 13.—MUNIDA MEXICANA, × $3\frac{1}{3}$.

The carapace is widest at about the beginning of the posterior third; from the widest point it tapers forward to a rather narrow front. The ciliated lines are unusually distant; the cilia are short.

There are eight spines on the gastric area, six in a transverse line and two separated by the length of the first ciliated line. There is a paired spine in the fork of the cervical suture; no spines occur posterior to these.

The rostrum is nearly twice the length of the eyes, its upper margin is slightly roughened; the supraocular spines are about one half the length of the eyes and twice the size of the antero-lateral spines. The merus of the maxillipeds is armed on the inferior border with three slender spines and by three small denticles and a spine on the opposite border. The merus of the anterior feet shows upward of twenty-five spines when viewed from above; the carpus is short and is armed with spines and spinules; the palm is short and spinulose; the fingers are much longer than the palm, and in some specimens have a large hiatus near the base. The abdomen is unarmed.

The length of the largest specimen is 12 mm. from the front to the end of the telson; length of the chelipeds, 29 mm.; length of dactyl, 10 mm.; length of palm, 5.2 mm.

Locality.—West coast of Mexico, 9 to 78½ fathoms; stations 2794, 2809, 2816, 2826, 2829, 2833, 2988, and 3012.

Type.—Cat. 20536, U.S.N.M., *Albatross* station 2816, off Galapagos Islands.

Variations: The proportionate length of the fingers varies.

MUNIDA NUDA, new species.

The carapace is broadest anteriorly. The transverse lines are widely separated and are almost devoid of cilia; the only unbroken line runs across the middle of the gastric region; it is conspicuous on account of its straightness and its ending at a spine on the sides of the gastric region. There are eight subequal spines on the gastric region four in a row near the front and a pair on each side near the hepatic region; the larger one of the pair is higher up on the area and at the end of the straight carinated line. The front is broad and produced in the middle. The supraocular spines are short and stout, not reaching more than one-half the length of the eyes.

The rostrum is compressed, serrate above, less so on the sides, and smooth below. The merus of the lower border of the maxillipeds is armed with one large spine. The chelipeds are strikingly different from those of any species examined. They are short; the merus has about ten spines; the largest are on the distal margin; the carpus has two or three large ones on the inner margin and a large number of smaller ones on the upper surface; the outlines of the hand are elliptical; spines run along the borders nearly to the ends of the fingers; there are upward of fifty spines on the outer surface; the inner surface is free from spines. The second segment of the abdomen has

four spines. Length of body, 12 mm.; length of cheliped, 17 mm.; of palm, 4 mm.; of fingers, 4 mm.

Locality. *Albatross* station 2338, latitude 23° 10′ 40″ N., longitude 82° 20′ 15′ W.; 189 fathoms. One male. Cat. No. 9516, U.S.N.M.

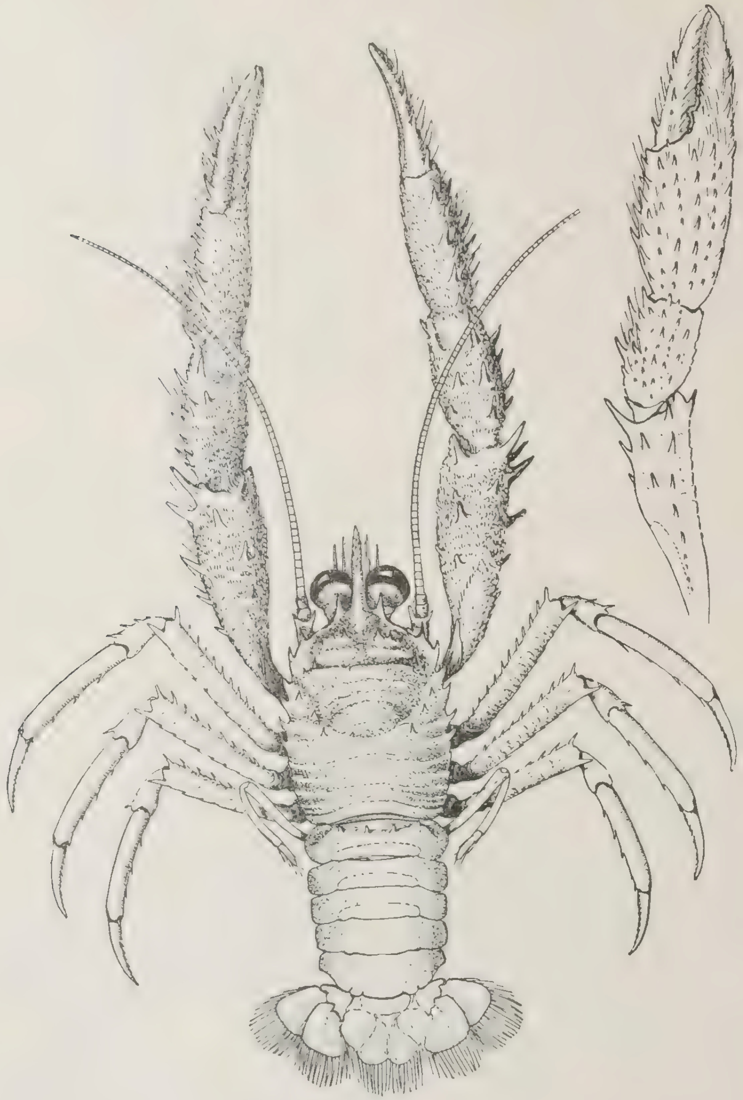

FIG. 14.—MUNIDA NUDA, × 4⅓.

MUNIDA PERLATA, new species.

The carapace is broadest in the middle, where it nearly equals the distance from the posterior border to the line of the gastric spines. In the single specimen obtained there are but two spines on the carapace; these are on the gastric area. In line with these, between and outside, are tubercles which in some specimens would probably occur as spines. The ciliated lines are elevated. There are six small spines on the margin behind the antero-lateral angle. The eyes are small

the cornea but little dilated and jet black. The merus of the maxillipeds is armed with a single very large spine. Only one of the chelipeds is present: this is short and much flattened. The spines of the merus are small, except those of the distal border, where there are four very large ones. There are two large spines on the inner margin of the carpus and smaller ones elsewhere. The hand is very hairy; there is a row of spines on each margin of the palm. The second segment of the abdomen has a row of spines.

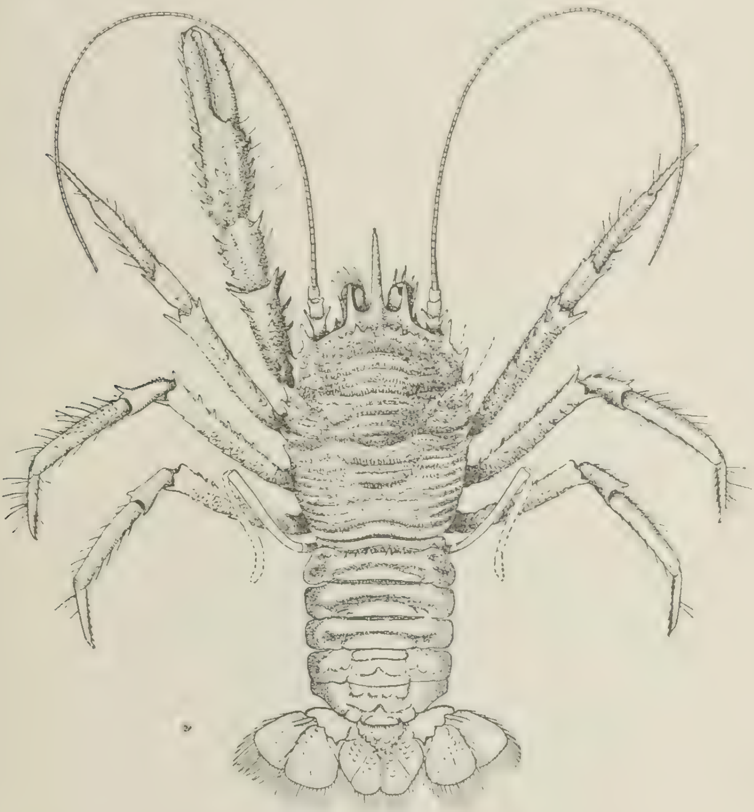

FIG. 15.—MUNIDA PERLATA, × 2⅓.

This species in some of its characters superficially resembles small specimens of *M. propinqua* Faxon and of *M. microphthalma* A. M. Edwards. From the first it is distinguished by its small eyes, from both by the armature of the maxillipeds. The supraocular spines are also much shorter in *perlata* than in *microphthalma*.

Length from the front to the end of the telson, 24 mm.; length of the cheliped, 21 mm.; length of palm, 4 mm.; length of fingers, 4 mm.

Locality.—Station 2808, off the Galapagos Islands; 634 fathoms. One female with eggs.

Type.—Cat. No. 20538, U.S.N.M.

MUNIDA PUSILLA, new species.

The carapace is broadest posteriorly; the sides are arcuate. The transverse lines of cilia are iridescent. The spines and spinules of the gastric area vary in number; the largest are those of the pair behind the supraocular spines; in line with these are one or more pairs of spinules; there is also a pair close to the hepatic area. There are two

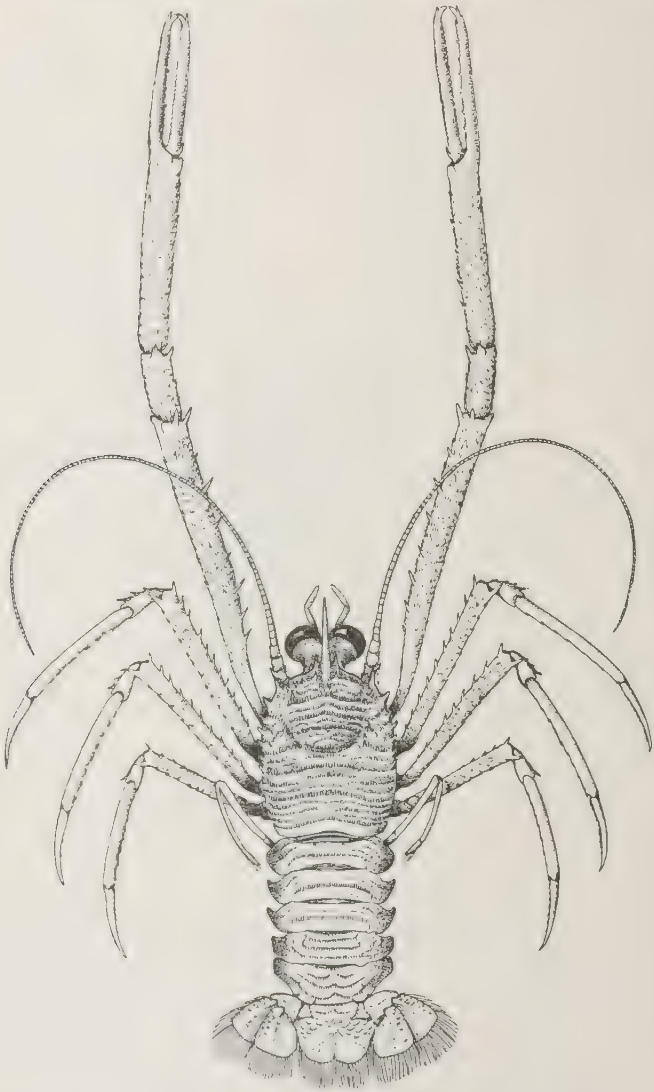

FIG. 16.—MUNIDA PUSILLA, × 4.

or three spinules in the fork of the cervical suture and one on the branchial region behind the fork of the suture. The sides of the front retreat a little to the antero-lateral angle. The supraocular spines are less than one-half the length of the eyes. The rostrum is long and slender and is raised but little above the horizontal. The superior mar-

gin of the maxillipeds is armed with but a single spine. The anterior feet in the male are very long and slender; in many specimens there is a prominent hiatus near the base of the fingers of one hand; in one specimen the hiatus exists in both hands. The spines, or rather spinules, of the merus are very small; the palm is scabrous, much as in *M. iris*. There are but few very small spines on the ambulatory legs; the only ones at all prominent are those at the distal ends of the merus and carpus. The second segment of the abdomen of many specimens has a widely separated pair of spinules; in other specimens with correlated characters the spinules are wanting.

The females are readily distinguished by the shorter and more spiny chelipeds. The spinules of the second segment of the abdomen are often wanting, as in the males.

Male: Length of body, 10 mm.; chelipeds, 28 mm.; palm, 8 mm.; fingers, 4.5 mm.

Locality.—*Albatross* station 2405, Gulf of Mexico; also, at stations 2120, Caribbean Sea; 2365, 2372, 2406, 2407, and 2640, Gulf of Mexico. A lot of three specimens is labeled "Warsaw, New Providence."

Type.—Cat. No. 20539, U.S.N.M. Station 2405.

MUNIDA QUADRISPINA, new species.

The carapace is narrowest near the front margin; the posterior angles are much rounded.

There are six spines on the gastric area, four in a line in the usual place behind the supraocular spines, and one on the sides near the hepatic region; the terminal spines of the line are very weak and small, but one spine occupies the anterior branchial region. The marginal spines vary from eight to ten in number.

The rostrum is long and compressed, moderately serrate above and slightly so below. The supraocular spines do not reach quite to the ends of the eyes; they are united to the rostrum for nearly one-half of their length. The eyes are small. The merus of the maxillipeds is armed on the inferior border with four spines; the first and last are long, the others short. The distal ends of the terminal segments of the maxillipeds are rather more dilated than is usual in the genus.

The anterior feet are well set with spines and spinules. The merus has fourteen spines; the carpus about twenty spines and spinules; and the palm upwards of thirty.

The ambulatory feet are compressed; the meral and carpal joints are spiny—spines short, blunt, inconspicuous.

Length of a large specimen, 35 mm.; length of palm, 15 mm.; length of fingers, 13 mm.

Locality.—*Albatross* station 2960; 267 fathoms, 2878.

Type.—Cat. No. 20537, U.S.N.M.

Also taken at stations 2861, 2866, 2871, 2878, 2886, 2936, 3053, 3104, 3170, 3183, 3445, 3449, 3454, 3457, 3461, 3666, and 3673. One speci-

men in the collection is labeled Sitka, Alaska, Dr. W. H. Jones, U. S. N., 1882, No. 13947.

The merus of the maxillipeds is commonly armed with four spines on the lower border; variations are numerous; while the two medium spines are usually smaller than the others. This is not always the case, as they may range from small tubercles to large spines.

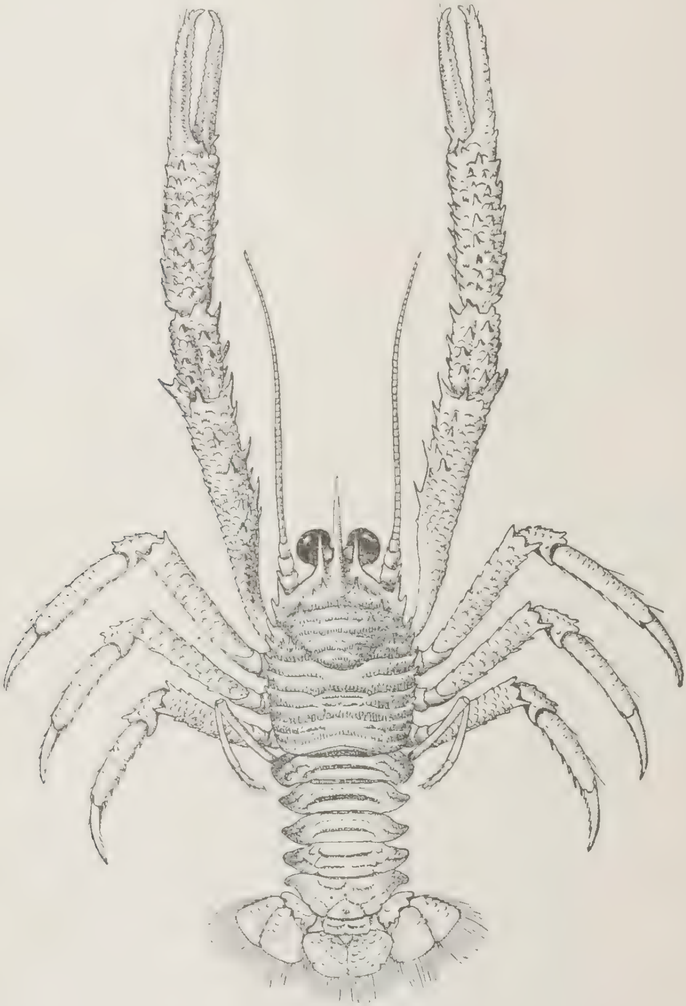

FIG. 17.—MUNIDA QUADRISPINA, × 1½.

MUNIDA SCULPTA, new species.

The carapace is broadest behind the middle, and is moderately swollen. The ciliated lines are rather more than usually elevated, and its anterior edges are thickly set with minute denticles. The cilia are worn from the anterior and central portions of the surface, but on the region near the fifth pair of legs are intact, and are brightly iridescent; the cilia cover about two-thirds of the space between the lines. The carapace is armed with more spines than is usual in species with

unarmed abdomens. A row of eight spines on the gastric area is arranged in size as follows: The gastric pair is the largest; the next are the second and fourth pairs; those of the third pair are little more than spinules; a little behind the third and fourth paired spines of the front row is a spinule, and on the sides are two other paired spines. On each of three females there is a denticle near the extremities of a ciliated line forming the anterior margin of the posterior lobe of the

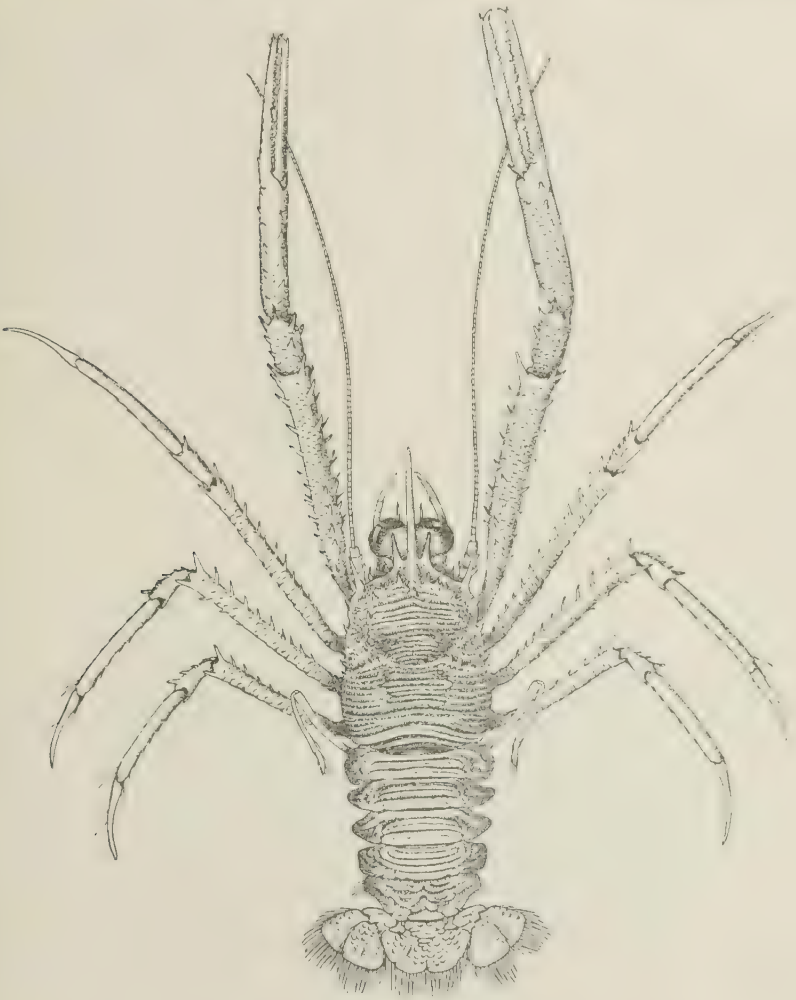

FIG. 18.—MUNIDA SCULPTA, × 2.

gastric area. These spinules are wanting in the three males. In the fork of the cervical suture are three or four spines; on the border behind the suture there is a row of from three to five paired spinules.

The rostrum extends beyond the eyes by more than one-half of its length, it is slender, slightly compressed, and is obscurely serrated above.

The supraocular spines extend to about the middle of the eye. The antero-lateral spines equal the supraoculars in length.

The inferior border of the merus of the maxillipeds is armed with three or more spines on the proximal and one on the distal end.

The chelipeds are shorter than those of *M. irrasa*. The merus has three rows of ten or more spines in good alignment; the surfaces on each side of the middle row are flat and diverge at an angle of 90 degrees. There are seven or eight spines on the carpus and two rows on the inside of the palm; all of the articles are scabrous throughout.

The abdomen is unarmed.

The type specimen is an ovigerous female, and is more nearly perfect than the others. Unfortunately, the exact locality is unknown; it is labeled "Caribbean Sea, 1884." All of the other specimens come from the north of Cuba. These specimens differ from the type in having the supraocular spines less divergent and in having three spines on the merus of the maxillipeds where the type has four; the distal terminal spine is also wanting in these specimens. The type measures from the front to the end of the telson 32 mm.; width, 12 mm.; length of chelipeds, 38 mm.; length of palm, 9 mm.; length of fingers, 9 mm.

Locality. Albatross station 2159; 98 fathoms; one male and one female.

(Station 27, Iowa State University Expedition; two males and one female.)

Type.—Cat. No. 8942, U.S.N.M.

MUNIDA SIMPLEX, new species.

The carapace is broadest behind; the transverse ciliated lines are well separated; the cilia are iridescent and extend forward one-fourth of the distance to the next line. There are six spines in line near the front of the gastric area and a single spine at the extremes of the first ciliated line. Two paired spines are situated in the fork of the cervical suture, making twelve spines in all on the surface of the carapace.

The eyes are large; the supraocular spines extend to the cornea. In the type specimen the lower border of the merus of the maxillipeds is armed with a long spine and three rudimentary ones in the other specimens; the merus has but one or two rudimentary ones.

The chelipeds are long and cylindrical, and under a lense they are lightly scabrous; the scale-like areas are bordered with iridescent cilia.

The merus has about twenty-five spines, large and small, in a dorsal view. The spines of the carpus are small; there is a row of small spines near the crest of the palm. The hands are long and a little curved inward, and bent slightly downward from the base of the fingers, which are a little longer than the palm. In the specimen selected for the type the chelipeds are unequal; the left one is the smaller, and has the most marked bend at the base of the fingers, making a large shallow sinus in the lower outline; the outline of the dactyl is concave; the curves in the right hand are not so strong as in the left, and

better represent the hands of the three specimens from the other stations.

The length of the body from the front to the end of the telson is 14 mm. The chelipeds are 34 and 37 mm. in length, respectively, and the palm of the right is 9 mm.; the fingers, 9.2 mm.

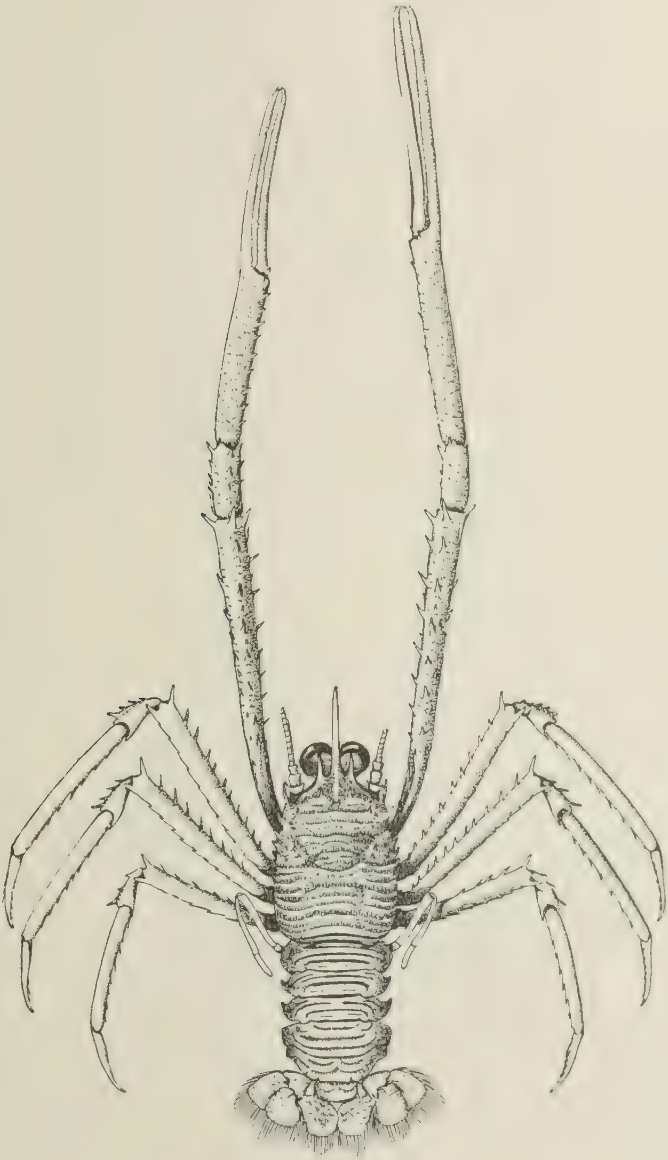

FIG. 19.—MUNIDA SIMPLEX, × 3.

Type.—Cat. No. 7789, U.S.N.M., from *Albatross* station 2169; depth 78 fathoms.

A second specimen was taken at station 2320 in 130 fathoms; two other specimens were taken at station 2322 in 115 fathoms; the three stations were off Habana, Cuba.

MUNIDA TENELLA, new species.

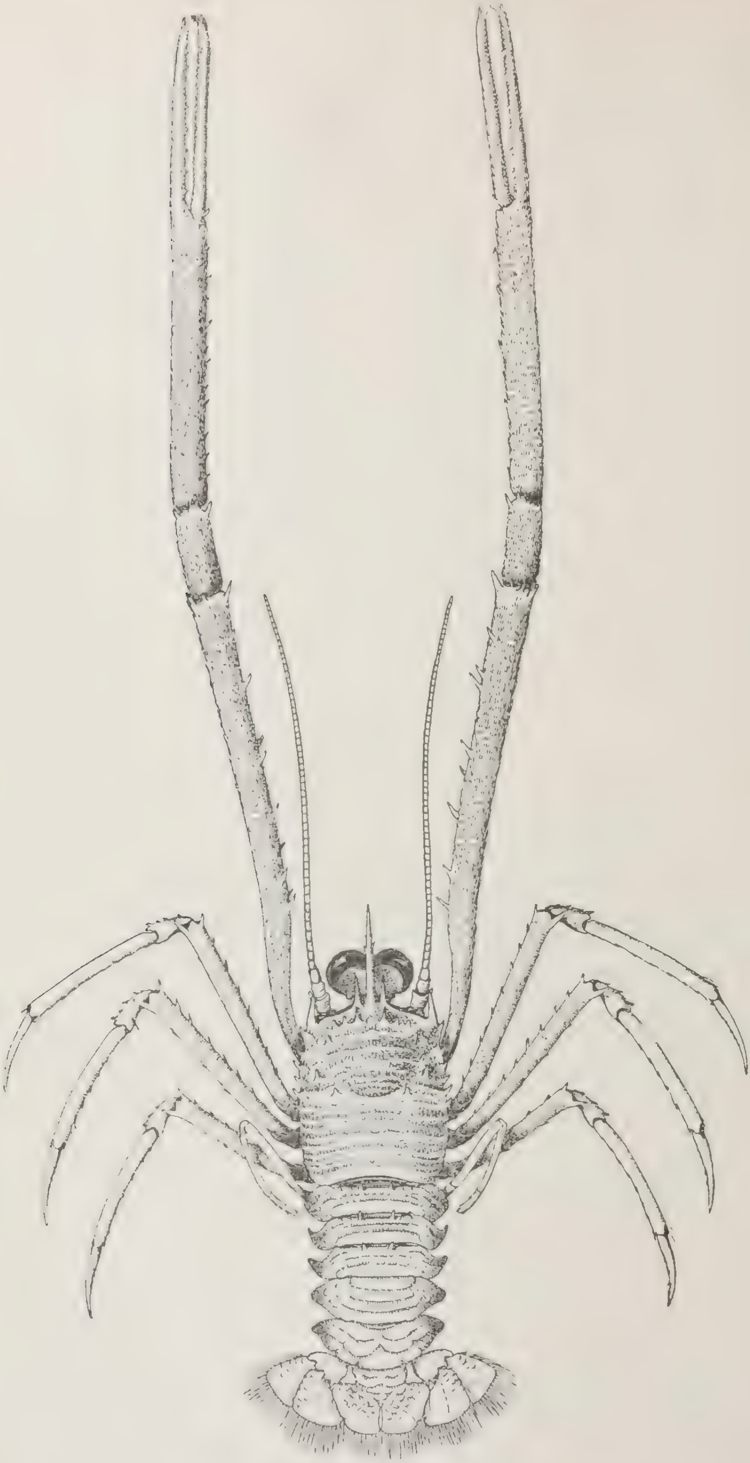

FIG. 20.—MUNIDA TENELLA, × 3.

The carapace is broadest in the anterior-middle, tapering slightly forward to the slender spines behind the antenna. The ciliated lines

are well separated, the cilia are short and slightly iridescent; the lines are for the most part unbroken. The gastric pair of spines is small, and the other spines of the gastric row are very small; in some specimens they should be designated as spinules. There are eight spines in the gastric row and two at the extremities of the first ciliated line, making ten spines on the gastric area. A large spine occupies the area in the fork of the cervical suture and a second paired spine the border just behind the fork.

The rostrum is about twice as long as the eyes; two or more spinules break the continuity of the sides; the upper border is subserrate. The supraocular spines are small and reach only about the middle of the eyes.

The eyes are large, the cornea is much inflated, and the peduncles are very short.

The inferior margin of the merus of the maxillipeds is armed with a large spine on the proximal part and by a short spine on the distal part. The merus of the chelipeds is armed with three rows of spines, the inner row with seven, the middle with six, and the outer with nine.

There are five spines on the carpus, three on the distal border, and two small ones on the inner margin. The upper margin of the palm has a row of from ten to fourteen small spines. The ambulatory feet are spinulose. The second segment of the abdomen has a line of six spines, the third and fourth two each.

Length of a large specimen, from the front to the end of the telson, 18 mm.; length of chelipeds, 39 mm.; of palm, 9 mm.; of fingers, 8 mm. Taken by the U. S. Fish Commission steamer *Albatross* at several stations off St. Josephs Island, Gulf of California, in from 39 to 71 fathoms.

Type.—Cat. No. 20540, U.S.N.M.

Variations: The gastric row of spines may have six spines in small specimens. The rostrum may show several spinules or none. The second segment of the abdomen may have but one pair of spines in some of the smaller specimens; usually six can be made out under a lens.

Genus MUNIDOPSIS Whiteaves.

KEY TO THE SPECIES OF MUNIDOPSIS EXAMINED.

a. Eye spines present.
- *b.* Eye spines short, conical.
  - *c.* Chelipeds short, bearing but few spines.
    - *d.* Carapace broadest behind; gastric area with six spines ..... *aculeata*, p. 315
    - *d.* Carapace broadest in front; gastric area with two spines . *subsquamosa*, p. 327
  - *c.* Chelipeds elongated, bearing numerous spines.
    - *d.* Abdomen unarmed.
      - *e.* Auxiliary eye spine at the base of the large eye spine ...... *scabra*, p. 325
      - *e.* Auxiliary eye spine wanting .... *tanneri*, p. 327
    - *d.* Abdomen armed .... *hystrix*, p. 321
- *b.* Eye spines long.

c. Without spines or teeth on the front behind the antennal peduncle.
  d. With four spines on the posterior margin of the carapace ....*bairdi*, p. 317
  d. Without spines on the posterior margin; margin roughened by a large number of sharp granules.
    e. Rostrum straight ....*antonii*, p. 316
    e. Rostrum curved..*beringana*, p. 279
c. With spines or teeth on the front behind the antennæ.
  d. Spines wanting on the gastric area ....*spinoculata*, p. 327
  d. Spines on the gastric area two or more.
    e. One eye spine ....*crassa*, p. 318
    e. Two eye spines.
      f. Crest of palms spiny.
        g. Merus of chelipeds with ten to twelve spines (exclusive of the terminal spines) ....*similis*, p. 326
        g. Merus of chelipeds with six to eight spines ....*verrilli*, p. 291
      f. Crest of palms not spiny ....*nitida*, p. 323
a. Eye spines not present.
  b. Rostrum broad, with subparallel sides; extends considerably beyond the eyes where it terminates in a trident.
    c. Rostrum long and strongly bent upward, as in Galicantha.
      d. Carapace without spines except on margin ....*expansa*, p. 282
      d. Carapace with spines on the surface ....*gilli*, p. 283
    c. Rostral point short, horizontal (Galathodes).
      d. Gastric area armed with two spines or spinules.
        e. Palm spiny above and below ....*trifida*, p. 329
        e. Palm not spiny..*mina*, p. 285
      d. Gastric area without spines or spinules.
        e. Maxillipeds with the inferior margin of merus armed with three spines.
          f. Sides of rostrum convex..................................*tridentata*, p. 328
          f. Sides of rostrum straight ....*bahamensis*, p. 278
        e. Maxillipeds with the inferior margin of the merus armed with two spines.
          f. Both spines slender from the base.
            g. Carpus of chelipeds with a single long slender spine.*tenuirostris*, p. 289
            g. Carpus with three long slender spines................*latifrons*, p. 321
          f. Both spines not slender.
            g. Fingers of the chelipeds acuminate from base to tip.*acuminata*, p. 277
            g. Fingers not acuminate...................................*modesta*, p. 286
  b. Rostrum not tridentate.
    c. Abdomen unarmed.
      d. Eyes movable.
        e. Gastric area with two very short conical spines ....*platirostris*, p. 324
        e. Gastric area without spines.
          f. With a sharp spine at the anterolateral angle.
            g. Rostrum broadest at base.
              h. Spine of anterolateral angle very short.........*cylindropus*, p. 281
              h. Spine of anterolateral angle long ....*sigsbei*, p. 326
            g. Rostrum broadest in the middle ....*armata*, p. 316
          f. Without spine on the anterolateral angle.
            g. Eyes long, cylindrical ....*cylindrophthalmus*, pp. 319, 281
            g. Eyes short ....*polita*, p. 324
      d. Eyes immovable.
        e. Surface of carapace smooth, punctate ....*espinis*, p. 282
        e. Surface of carapace rough, coarsely granulated..........*squamosa*, p. 327
    c. Abdomen armed with spines or tubercles.

d. Rostrum armed with lateral spines.
e. Rostrum armed with a single pair of lateral spines.
f. Posterior margin unarmed .... *crinacea*, p. 320
f. Posterior margin armed with spines.
g. Spines four to six .... *spinifer*, p. 327
g. Spines numerous, small .... *sericea*, p. 326
e. Rostrum armed with two or more spines on each side.
f. Eyes immovable .... *opalescens*, p. 287
f. Eyes movable .... *hamata*, p. 320
d. Rostrum not armed with lateral spines.
e. Armature of the abdomen not confined to the median line.
f. Armature of abdomen consisting of small conical spines, uniform in size, placed in a double row on the second, third, and fourth segments .... *scobina*, p. 325
. Armature consisting of prominent spines on the median line and a single spine on each side.
g. Spines on the posterior margin of carapace, 2 ..... *serratifrons*, p. 326
g. Spines on the posterior margin of carapace, more than 2. *hastifer*, p. 284
e. Armature of abdomen confined to the median line.
f. Gastric area armed with 1 or more spines or tubercles.
g. Rostrum depressed .... *latirostris*, p. 321
g. Rostrum curved upward.
h. Median line on the gastric area free from spines ..... *villosa*, p. 330
h. Median line on the gastric area armed with spines or tubercles.
i. Orbicular sinus well developed.
k. Rostrum strongly curved upward and much longer than the eyes .... *robusta*, p. 325
k. Rostrum nearly horizontal and but little longer than the eyes. *townsendi*, p. 290
i. Orbicular sinus lacking.
k. Carapace of nearly uniform width, widest in middle, not cut up into lobes .... *simplex*, p. 326
k. Carapace not uniform in width, cut into lobes by cervical sutures.
l. Broadest near anterior end .... *longirostris*, p. 322
l. Broadest near posterior end .... *curvirostra*, p. 319
f. Gastric area lacking spines or tubercles.[a]
g. With sharp anterolateral spines .... *abbreviata*, p. 315
g. Anterolateral spines wanting.
h. Rostrum short, broad, concave, apex rounded.
i. Carapace of uniform width .... *longimana*, p. 322
i. Carapace broadest in front .... *carinipes*, p. 317
h. Rostrum acuminate.
i. Lateral margins of carapace straight .... *quadrata*, p. 325
i. Lateral margins arcuate .... *aspera*, p. 316

MUNIDOPSIS ACUMINATA, new species.

The rostrum extends beyond the eyes about one-third of its length: the base is broad; the rostral point is twice as long as the lateral points. The antennal spines are a little smaller than the rostral spines. The spines of the lateral margin are four in number, including the

[a] *M. aspera* may be an exception, as the rough granules are general on the carapace.

anterolateral spine. The posterior spine is situated just behind the branch of the cervical suture, as indicated by a slight notch; the anterior branch of the suture ends in a notch just behind the anterolateral spine; both branches are indistinct, while the groove is well marked behind the gastric area.

FIG. 21.—MUNIDOPSIS ACUMINATA, × 2.

The carapace is roughened by short, granulose rugæ; there are no spines on any part of the gastric area. The spines of the ambulatory legs are confined to the crests of merus and carpus. The chelipeds have spines on the crest and on the inner margin of the merus and on the distal margin of the carpus.

The lower margin of the hand is nearly straight, with a slight swelling at the palm and a slight sinus at the base of the fingers; the fingers are acuminate, the outline of the closed fingers from the base to the tip is triangular. This feature distinguishes the species from all related forms of the subgenus Galathodes.

The two specimens, one male and one female, were taken by the *Albatross* at station 2663, in 421 fathoms, off South Carolina.

Type.—Cat. No. 11490, U.S.N.M.

MUNIDOPSIS BAHAMENSIS, new species.

The rostrum is seven-eighths as long as it is broad at the base, measured from the base to the base of the lateral points; between the points it is three-fourths the length of the base. The lateral teeth are large and stand out well from the margin. The inferior margin of the merus of the maxillipeds is armed with three spines; the proximal spine is broad at the base; the second is as long and is uniform in size; the third is short, sometimes inconspicuous or wanting. The merus of the chelipeds has two rows of spines and two large spines between them; the carpus has a large spine at the inner angle and a smaller one at the condyle; the palm is broad and unarmed; in large specimens there is a hiatus between the fingers. The upper margins of the meral joints of the ambulatory feet bear a row of spines; the

carpal joints have a single spine placed at the distal angle of the upper margin.

Length of a large male from the front to the end of the telson, 44 mm.; length of chelipeds, 51 mm.; length of the carapace, 18 mm.; width, 16 mm.

Locality.—*Albatross* station 2669, 352 fathoms, off the coast of Florida.

Type.—Cat. No. 20555, U.S.N.M.

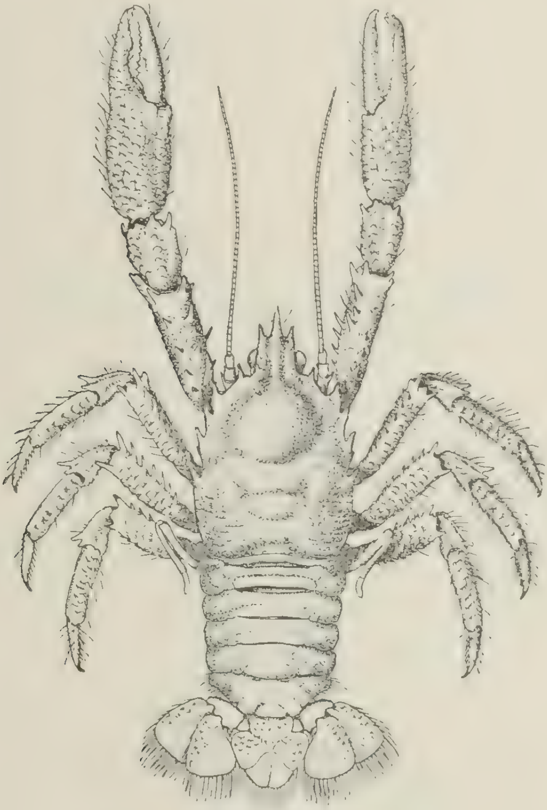

FIG. 22.—MUNIDOPSIS BAHAMENSIS, × $1\frac{1}{4}$.

MUNIDOPSIS BERINGANA,[a] new species.

Three specimens of a Munidopsis were dredged in Bering Sea, which at first sight would be called *M. antonii;* but a careful examination shows that the texture of the carapace differs, that the rostrum is curved and not as in *M. antonii*, which, though directed upward, is perfectly straight.

The carapace of the Bering Sea species is, in its texture, more like

[a] Allowance must be made for the figure of this species, as the specimens were soft; the exuviæ still partly attached to one. The small one is, however, hard, and this confirms the specific characters given to the large specimens. The short rugose lines of the posterior sides are more marked in the specimens than in the figure.

that of the *M. antonii* figured by Henderson in the *Challenger* Anomura. The sharp granules are arranged in short lines or squamæ on the posterior portion of the carapace. The specimen figured has about twenty short, sharp spines on the gastric area. The smallest specimen, a male, has fifteen; a large female, with a part of the exuviæ yet attached, has the same spination as a specimen of *M. antonii* from the Paris Museum of Natural History (taken by the *Talisman*), but otherwise it is like its companions. The *Talisman* specimen and the Bering Sea species agree in being broadest behind and tapering gradually forward; the *Challenger* figure shows a species slightly narrower a little beyond the middle; the figure of the latter also shows

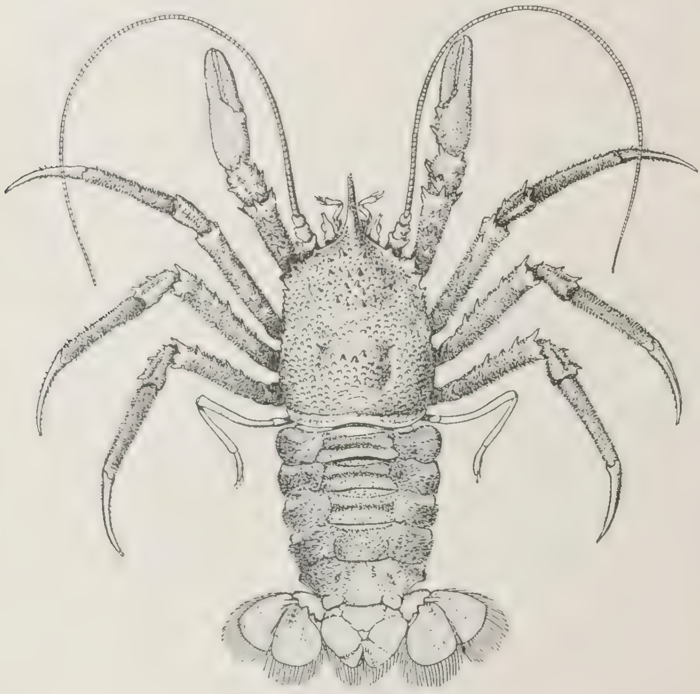

FIG. 23.—MUNIDOPSIS BERINGANA, × $\frac{2}{3}$

a slight difference in the spines of the gastric area—a single spine in the center where the other species have two. In comparing *M. beringana* with *M. aculeata* Faxon, the spination of the gastric area is very similar. The cornea of aculeata is much larger than *beringana* and the eye-spines smaller; the rugæ of the posterior portion of the carapace are coarse and separated in *aculeata*, and exceedingly numerous and crowded in *beringana*

Length of the large female, figured from the middle of the posterior margin to the margin behind the eye, 32 mm.; greatest width, 28 mm.

Locality.—From *Albatross* station 3603, 1,771 fathoms.

Type.—Cat. No. 20557, U.S.N.M.

MUNIDOPSIS CYLINDROPUS, new species.

The rostrum is sharp; the distal one-half is triangular in cross section; it extends horizontally forward beyond the eyes by about one-half of its length. From the apex to the eyes the upper margin is a sharp ridge; from this point the ridge is forked, the branches running back to the front of the gastric areolation, inclosing a slight triangular depression. The antero-lateral angles are right angles with sharp apices; that portion of the front which lies between the bases of the antennæ is much advanced beyond the line of the angles.

The articles of the antennal peduncles are each about as long as broad; the flagelli are long and thread-like, reaching far beyond the chelipeds.

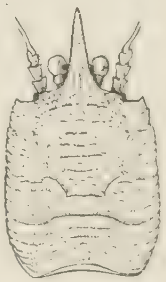

Fig. 21.—Munidopsis cylindropus. 3.

The carapace is 5.5 mm. in breadth and 6.5 mm. in length, measured from the front behind the eye; the lateral margin is but slightly arcuate from the middle to the front, but much more so posteriorly. The areolations are protuberant; the surface is everywhere broken by raised transverse lines varying greatly in length.

The chelipeds measure 20 mm. in length and are almost uniformly 1 mm. in diameter throughout, the palm enlarging to 1.2 mm. at the base of the dactyl. The merus and carpus are granulated, while the palm is smooth and slightly iridescent; two spines arm the inner surface of the merus and two or three the distal margins of both merus and carpus.

The fingers are shorter than the palm; their prehensile edges are thin and minutely dentate. The ambulatory feet are granulated; with the exception of a small graduated comb under the dactyls they are free from spines.

The merus of the maxillipeds is armed with two spines.

The abdomen is wanting in both spines and tubercles; the margins of the second, third, and fourth segments are raised, forming deep transverse channels.

This species in its general appearance very much resembles *Munidopsis cylindrophthalmus*, but close inspection shows marked differences in many characters. The latter species has a much broader rostrum and smaller eyes; the carapace is much smoother, and its antero-lateral angles are rounded.

This single specimen, a female without eggs, was taken by the *Albatross* at station 3697, in 265–120 fathoms, off Honshu Island, Japan.

Type.—Cat. No. 26163, U.S.N.M.

MUNIDOPSIS ESPINIS, new species.

The rostrum is about three times as long as broad in the middle; the apex is blunt. The carapace is about as broad as long, subquadrate; the antero-lateral angle is formed by a broad, triangular, blunt tooth, which projects beyond the base of the rostrum. The margin between the rostrum and the tooth is divided by a triangular projection into two parts; the inner part is semicircular. In this the eye is immovably fixed both to the front and rostrum. On the margin behind the antero-lateral tooth is a double-pointed tooth; behind this and in front of a deep transverse depression is a small tooth.

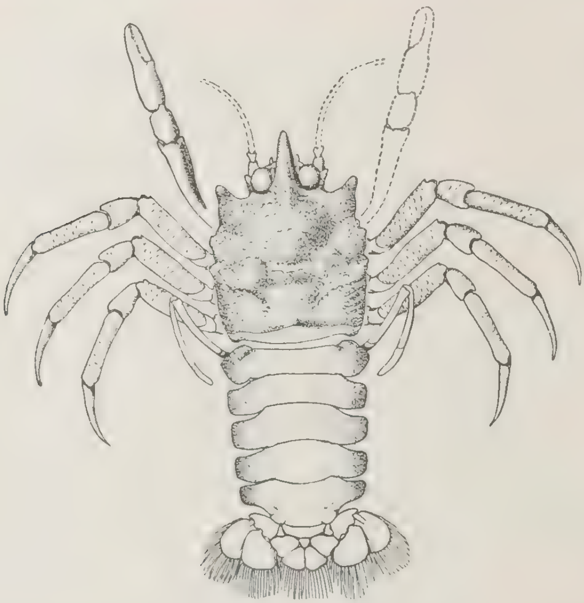

Fig. 25.—Munidopsis espinis, × 2⅓.

This species is altogether without spines, with the exception of two on the merus of the maxillipeds.

The carapace is 7.5 mm. in each dimension.

Locality.—*Albatross*, station 2351, 426 fathoms, off Yucatan.

Type.—Cat. No. 20559, U.S.N.M.

MUNIDOPSIS EXPANSA, new species.

The front extends forward horizontally and ends in two points and a sharply upturned rostrum. The carapace is very broad, and, excepting on the margin, is altogether devoid of spines; the surface is rather crowded with short, semicircular, raised lines; the antero-lateral angles are formed by triangular teeth, the points of which are directed forward; behind the angles are two teeth on a small lobe and a third one at about the middle of the margin. The merus of the maxillipeds is unarmed. The distal margins of the meral joints of both the chelipeds

and ambulatory legs are armed with tubercular spines; the chelipeds are much shorter than the body.

Length of the body from the tip of the rostrum to the end of the telson, 52 mm.; length of the chelipeds, 30 mm.; length of carapace from the sinus behind the eye, 20 mm.; breadth in the middle, 22 mm.

Locality.—Station 2663, 421 fathoms, off Florida.

Type.—Cat. No. 20561, U.S.N.M.

FIG. 26.—MUNIDOPSIS EXPANSA, $1\frac{1}{3}$.

MUNIDOPSIS GILLI, new species.

The rostrum projects forward and ends in two horizontal points and a sharply upturned rostral point, as in Galicantha. The portion of the front behind the rostrum is unarmed. The lateral margins are very uneven. A lobe bearing a small spine marks the antero-lateral angles; behind the angle is a lobe with two points, followed by a sinus, then another short spine or point. There are eight or more small tubercular granules on the posterior border and numerous similar granules scattered over the carapace and legs. The different areolations are protuberant; the gastric area is surmounted by three spines, placed at the points of an equilateral triangle; there are two short spines on the cardiac area. The merus of the maxillipeds is armed with three spines; the first is very stout at the base, the second is slender, the third is short.

The chelipeds are shorter than the body. The second, third, and fourth segments of the abdomen are each armed with a single spine.

Length of body from the rostrum to the end of the telson, 58 mm.; length of carapace from behind the eyes, 24 mm.; breadth, 19.5 mm.

Locality.—*Albatross*, station 2629, 1,169 fathoms, off Bahama Islands.

Type.—Cat. No. 20562, U.S.N.M.

Named for Dr. Theodore Gill, associate in zoology, U. S. National Museum.

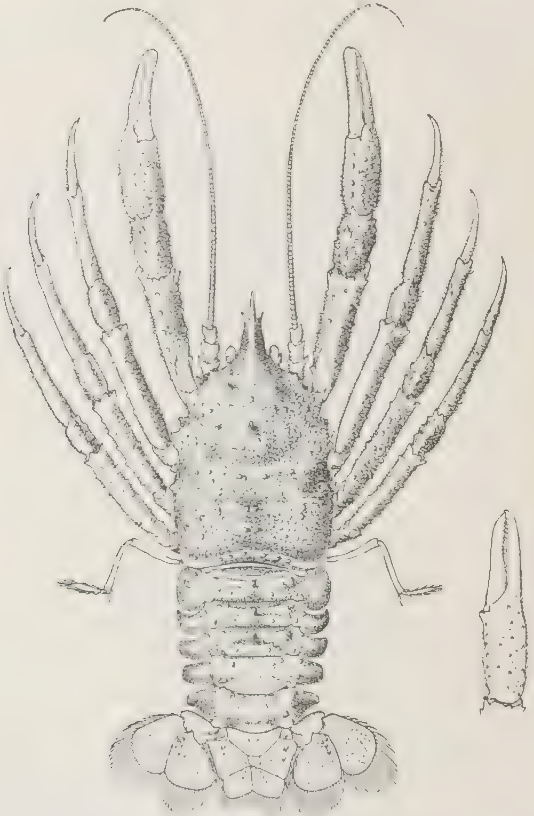

Fig. 27.—Munidopsis gilli, × 1.

MUNIDOPSIS HASTIFER, new species.

The rostrum is rather broad, its sides are arcuate, the apex is acute, and the margin is cut into small serrate teeth; a prominent carina runs from the apex to the highest part of the gastric protuberance. The sides and front meet in an obtuse angle which is armed at the apex with a small spine.

The front runs forward from the angle to a point almost under the eye, then back around the eye to the rostrum, leaving the eye in a semicircular orbit in which the eye moves slightly.

The carapace is about one-sixth longer than broad, the areolations are protuberant and curiously armed with compressed spines, many

having sharp procurved points, especially those near the sides of the carapace; the gastric area has two large spines of this nature and numerous smaller ones. There are two on the median line on the cardiac area. The posterior margin of the carapace is raised, the middle third is free from spines, but on either side of this space is a pair, rather large and procurved.

The chelipeds are about three times the length of the carapace, not including the rostrum; the merus is set with rows of elongated granules, the middle inner surface is set with three sharp spines on one cheliped and with two on the other; there are three spines on the distal margin. The armature of the carpus is similar; the palm is thickly set with small spiny granules below, large ones run along the upper margin in a well-formed line. There is a line of hair along the ridge of the movable finger; the hiatus formed by the fingers is set with hair. The ambulatory feet are thickly set with spiny granules.

FIG. 28.—MUNIDOPSIS HASTIFER. 2½.

The second and third segments of the abdomen are armed with spines, the second segment has two spines in a central position on the posterior margin, and a paired group of two on the surface nearer the side; the third segment has a spine on the median line on the anterior margin and a pair separated by the line on the posterior margin, also smaller spines near the sides.

The carapace of the largest specimen, a female without eggs, is 9.5 mm. in length measured from the orbit, and 8 mm. in width; the chelipeds are 28 mm. in length, the palm at the base of the dactyl is 3.2 mm. in width, the fingers are 4.5 mm. long, and the palm 6.8 mm.

Three specimens were taken at *Albatross* station 3697 in 265–120 fathoms, off Honshu Island, Japan.

Type.—Cat. No. 26164, U.S.N.M.

MUNIDOPSIS MINA, new species.

The rostrum is about as long as broad, measured from its base to the base of the lateral points. The distance between the lateral points is about five-eights of the length of the base. The carapace is elongated; the sides are slightly arcuate and armed with four short spines.

There are two short spines on the gastric area, as in *M. tridens*

A. M. Edwards. The merus of the maxillipeds is armed with four spines. The first is very broad, but sharp pointed; the second is slender; the third and fourth are short. The merus of the right cheliped has a row of small spines on the upper margin and three or four large spines on the inner surface. The carpus is armed on the distal margin with five spines. The palm is slender, a little compressed, smooth on the sides, granular above and below.

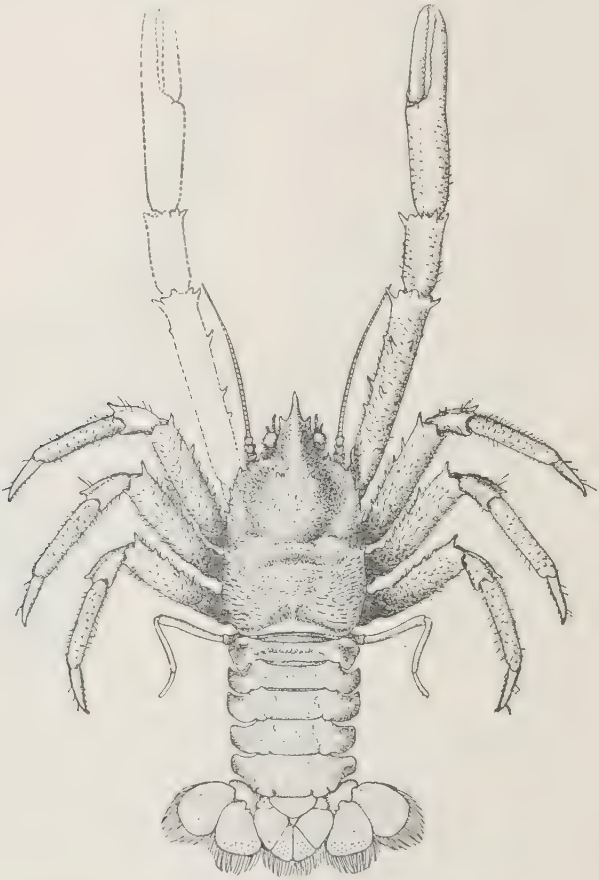

FIG. 29.—MUNIDOPSIS MINA, × $1\frac{1}{3}$.

Length of body from the tip of the rostrum to the end of the telson, 40 mm.; length of carapace from the front to the posterior margin, 16 mm.; width of carapace, 12.5 mm.

Locality.—*Albatross* station 2818, 392 fathoms, off Galapagos Islands.

Type.—Cat. No. 20557, U.S.N.M.

MUNIDOPSIS MODESTA, new species.

The rostrum is broad; the rostral point is very much longer than the lateral points at its base.

The antero-lateral and other marginal spines are small for this section of the genus. The carapace is inconspicuously set with short hair;

the hair on the chelipeds and ambulatory legs is long, but not at all dense. There are no spines on the carapace.

The inferior margin of the merus of the maxillipeds is armed with two short, sharp-pointed teeth. The spines on the merus of the chelipeds vary in number, in most specimens there are four or five on the inner surface. There is but a single true spine on the carpus, situated at the inner angle. The hands are smooth; the palms are rather broad. The ambulatory feet are almost unarmed; the terminal spines of the meral and carpal joints are the most conspicuous.

FIG. 30.—MUNIDOPSIS MOD[illegible] 3.

Length of the carapace from the front behind the eyes, 8.5 mm.; breadth of carapace, 7 mm.; length from the tip of the rostrum to the end of the telson, 22 mm.; length of chelipeds, 22 mm.

Locality.—*Albatross* station 2818, 392 fathoms, off Galapagos Islands.

Type.—Cat. No. 20553, U.S.N.M.

A number of specimens, one small female with eggs.

MUNIDOPSIS OPALESCENS, new species.

The rostrum is sharp pointed, triangular in section, armed on the sides with three or four spines irregularly placed. The carapace is subquadrangular in shape; the antero-lateral angles are armed with a

single spine, which stands out diagonally and curves forward. The areolations are very protuberant; three spines arise from the gastric area, a transverse pair near the front and one on the median line farther back. There is a large spine on the cardiac area, followed by one or more smaller ones; three spines on the post-branchial area are in line near the margin; behind the antero-lateral angles there are three spines on the margin. The posterior border is armed with six or

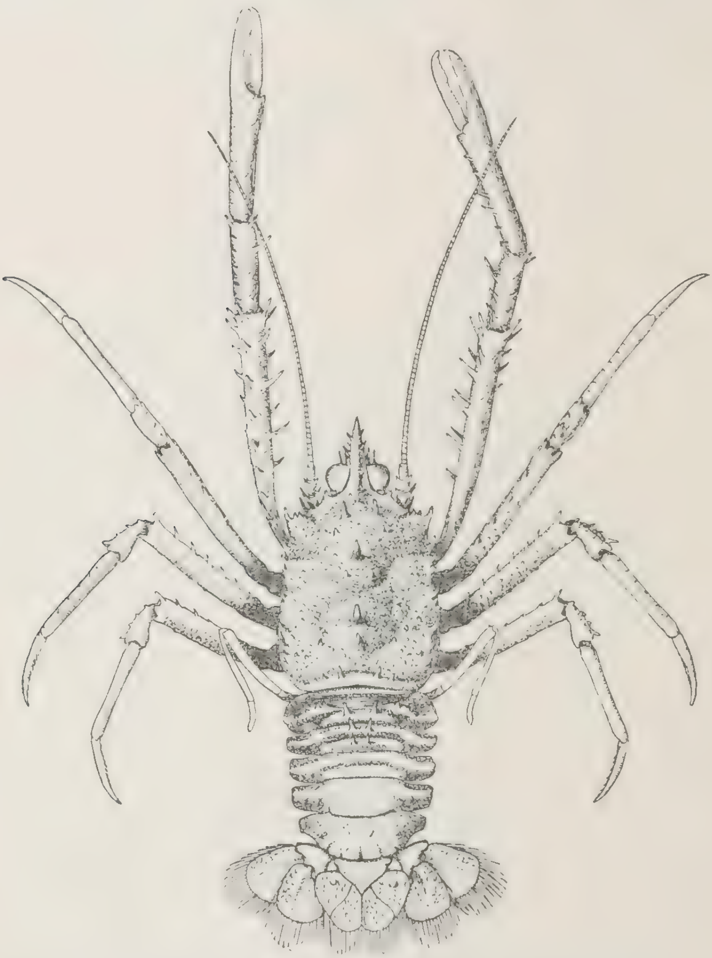

FIG. 31.—MUNIDOPSIS OPALESCENS, 2⅓.

more spines. In addition to the spines enumerated there are a variable number of spinules and spiny granules scattered over the surface.

The second segment of the abdomen is armed with two large spines; anterior to these at the sides are one or more paired spinules. The third segment is armed with four spines, a pair on each of the two ridges; the anterior pair are the larger. The inferior margin of the merus of the maxillipeds is armed with four spines, the third is usually the shortest; the superior margin has three or four small denticles.

The chelipeds are slender; the spines on the merus are distantly placed in three principal rows; there is a very large spine at the inner angle of the carpus; many smaller ones are arranged in three rows. The palm has a single row of spines on the superior margin; the fingers are short. Color very light, with brilliant opalescent reflections.

Length of a female from the margin behind the eyes to the end of the telson, 20 mm.; length of chelipeds, 27 mm.

Locality.—*Albatross* station 2781 in 348 fathoms and 2785 in 449 fathoms, off Patagonia.

Type.—Cat. No. 20558, U.S.N.M.

MUNIDOPSIS TENUIROSTRIS, new species.

The length of the rostrum from base to tip is equal to one-half the width of the carapace at the antero-lateral angles; the distance between the lateral points is two-fifths of the length of the base. The carapace is hairy and devoid of spines; the anterior half of the lateral margin is straight in the male and a little arcuate in the female; the margin between the spine above the antennæ and the base of the rostrum is transverse; the antero-lateral and other spines of the margin are subequal.

The inferior margin of the merus of the maxillipeds is armed with two slender spines and one very short conical one. There are two rows of spines on the merus of the chelipeds, with two large spines between them; the hands are flattened and a little elongated.

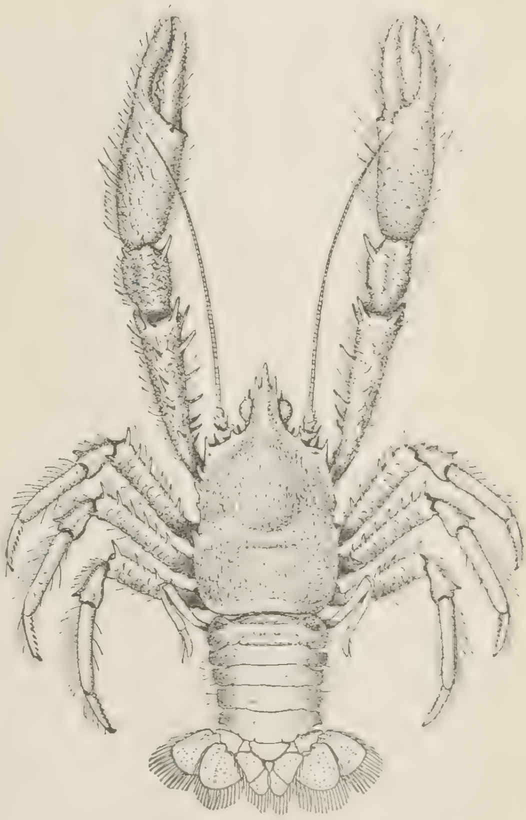

FIG. 32.—MUNIDOPSIS TENUIROSTRIS, × 2.

Length of the carapace from the margin behind the eye to the middle of the posterior margin is 11 mm.; breadth of carapace, 9 mm.; length of cheliped, 32 mm.

Locality.—*Albatross* station 2415, 440 fathoms, off the coast of Georgia.

Type.—Cat. No. 20560, U.S.N.M.

MUNIDOPSIS TOWNSENDI, new species.

The carapace is a little longer than wide, measuring from the base of the rostrum. In shape it is almost as quadrate as *M. quadratus* Faxon. The areolations are protuberant, and the entire surface is thickly set with tubercular granules subequal in size. These granules extend to the end of the rostrum. The rostrum is short and narrow, extending but little beyond the eyes. A tooth on the margin behind the antennæ forms the outer angle of the orbital sinus.

The posterior margin is armed with granules of the same size and character as the surface of the carapace.

The second and third segments of the abdomen are armed each with a large tubercle; the tubercles and the surfaces of the segments are covered with the same granulations as the carapace; the other segments are smooth.

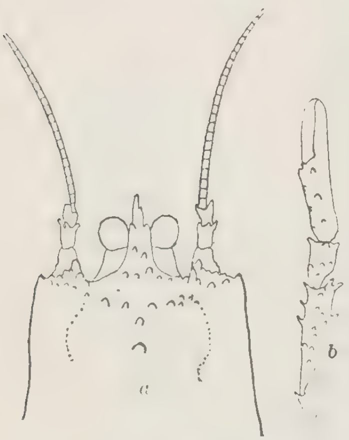

FIG. 33.—MUNIDOPSIS TOWNSENDI, $a \times 3\frac{1}{2}$, $b \times 2$.

The upper surface of the merus of the cheliped is armed with about fifteen short and very stout spines; the lower surface is semicylindrical and smooth; the carpus is armed with nine to twelve short tubercles.

The palm is rather longer than the fingers and a little narrower. On the outer surface, in line with the gape of the fingers of the right hand, are the three largest spines on the cheliped; near the crest and parallel with the line of large spines is a row of very much smaller ones. The fingers are compressed, thin, and evenly toothed on the prehensile edges. On the left hand the three spines behind the gape are replaced by six smaller ones, and one or two of the parallel rows are hardly indicated.

The merus of the ambulatory feet is tubercular or spiny on the distal half, the carpus is tubercular, and the propodus is smooth with the exception of a line of three to four conical spines on the upper surface. The dactyls are short and much curved. The merus of the maxillipeds is armed with two short, stout spines.

Length of carapace, from base of rostrum, 7 mm.; greatest width, 8 mm.

Named for Mr. C. H. Townsend, who served as naturalist on the U. S. Fish Commission steamer *Albatross*.

The type is a female with eggs from *Albatross* station 2818.

Type.—Cat. No. 26167, U. S. N. M.

MUNIDOPSIS VERRILLI, new species.

The rostrum is slender and triangular in cross section; the upper margin runs back as a carina to a point behind the spines of the gastric region; the rostrum is slightly bent upward. The front from the base of the rostrum to a point under the anterolateral spine is nearly straight and is at an angle of about 45 degrees to the median line. The eyestalks are armed with two spines, of which the inner is much the longer. The carapace is iridescent; the short and rather elevated rugæ are hairy. The abdomen is unarmed.

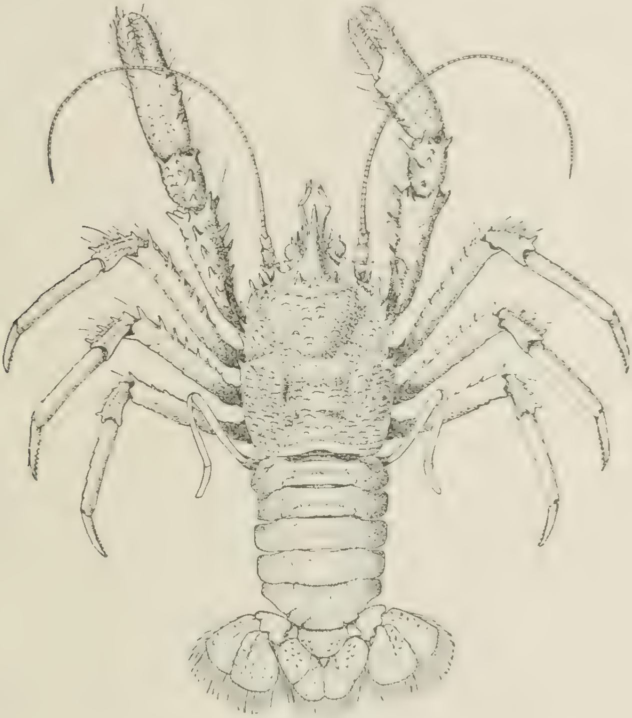

FIG. 34.—MUNIDOPSIS VERRILLI, × 1⅔.

The merus and carpus of the ambulatory legs are spiny. The merus of the chelipeds is triangular in cross section; it has four spines on the upper ridge and two on the inner; there are five or six spines on the carpus, and two prominent spines on the crest of the palm; the prehensile edges of the fingers are evenly dentate.

This species is related to *M. brevimana* Henderson and to *M. ciliata* Wood-Mason and to *M. nitida* Milne-Edwards.

Taken by the *Albatross* at stations 2919 and 2923, off southern California.

Named for Prof. A. E. Verrill.

Type.—Cat. No. 20656, U.S.N.M.

Genus UROPTYCHUS Henderson.

KEY TO THE SPECIES OF UROPTYCHUS EXAMINED.

a. Lateral margin of the carapace armed with spines or spinules.
  b. Merus without spines, except at the articulation with the carpus.
    c. Rostrum but little longer than the eyes.
      d. Gastric region smooth .... *armatus*, p. 330
      d. Gastric region rough .... *scandens*, p. 298
    c. Rostrum about twice the length of the eyes.................. *granulatus*, p. 293
  b. Merus spiny.
    c. Spines on the merus few.
      d. Rostrum broad, triangular, not twice as long as the eyes.... *minutus*, p. 296
      d. Rostrum about three times the length of the eyes .... *spiniger*, p. 298
    c. Spines on the merus numerous.
      d. Without spines on the gastric region .... *bellus*, p. 331
      d. With spines on the gastric region.
        e. Spines on the lateral margin short and stout .... *pubescens*, p. 332
        e. Spines on the lateral margin long and slender.
          f. Chelipeds long and slender; spines on the crest of the palm larger and more numerous than those of the lower margin ...... *spinosus*, p. 333
          f. Chelipeds stout, with spines of the crest and lower margin longer and about equal in size and number .... *princeps*, p. 296
a. Lateral margin of the carapace unarmed.
  b. Carapace and legs densely spinulose (including lateral margin) .. *rugosus*, p. 333
  b. Carapace not spinulose.
    c. Carapace pubescent .... *capillatus*, p. 293
    c. Carapace not conspicuously pubescent.
      d. Rostrum about twice the length of the eyes.
        e. Cornea not larger than the eyestalk .... *jamaicensis*, p. 294
        e. Cornea spreading, much larger than the eyestalk .... *nitidus*, p. 332
      d. Rostrum not twice as long as the eyes.
        e. Rostrum cylindrical .... *brevis*, p. 292
        e. Rostrum flat, triangular.
          f. Outline of hands arcuate on both margins................ *uncifer*, p. 333
          f. Outline of hands straight on both margins.
            g. Rostrum longer than eyes .... *occidentalis*, p. 332
            g. Rostrum much shorter than eyes .... *scambus*, p. 297

UROPTYCHUS BREVIS, new species.

The rostrum is short, subcylindrical, and blunt. The only armature of the carapace is at the antero-lateral angles, from which a fingerlike tubercle extends directly forward.

The carapace is remarkable for its dimensions, being much broader than long; the broadest portion is near the posterior margin; the front is about one-half the breadth; the sides are immarginate.

The merus of the maxillipeds is unarmed. The merus of the cheliped is cylindrical, armed at the distal upper angle with a single small spine; the carpus is a little compressed, with a row of 5 small tubercles on the upper margin and a spine and 2 tubercles on the distal border. The palm is compressed to a thin crest above; the crest is

serrate; the fingers touch only at the tips; a tubercle on each extends across the hiatus. The propodal joints of the ambulatory legs are flattened and curved, forming more than a semicircle in connection with the curved dactyls.

Length of the carapace from the margin behind the eyes to the end of the median line, 5.5 mm.; breadth, 6.8 mm.; length of rostrum, 1.5 mm.

Locality.—Albatross station 2351 in 426 fathoms, lat. 22° 41′ 00″ N.; long. 84° 16′ 30″ W., off Yucatan.

FIG. 35.—UROPTYCHUS BREVIS, × 1⅔.

Type. Cat. No. 20566 U.S.N.M., female with eggs.

UROPTYCHUS CAPILLATUS, new species.

The rostrum is as long as the carapace; its breadth at the base is equal to one-half of its length. The carapace is broader than long, armed on the lateral margin with a number of spinules; all surfaces are granular and covered with short hair. This species is much nearer to *U. rugosus* than to any other in the collection; it differs in having a dense coat of short hair where in *rugosus* it is long and scattering; the spines of the margin of the ambulatory legs are smaller and more numerous in *capillatus;* the upper margins of the propodal joints of the ambulatory legs are spiny only on the proximal half in *rugosus.* In this species the whole margin is spiny. The chelipeds are wanting in both specimens.

FIG. 36.—UROPTYCHUS CAPILLATUS, × 3⅓.

Length of carapace, 3 mm.; breadth, 4 mm.; length of rostrum, 3 mm.

Locality.—Albatross station 2353 in 167 fathoms, lat. 20° 59′ 00″ N., long. 86° 23′ 00″ W.

Type.—Cat. No. 20565 U.S.N.M.

UROPTYCHUS GRANULATUS, new species.

The rostrum of a large female is 5 mm. long, is broad at the base, and sharp at the apex. It is slightly depressed, in conformity to the curve of the convexity of the carapace; it is deeply concave at the base. The antero-lateral angles are armed with stout spines. Near this is a smaller spine at the outer angle of the broad and deep orbital sulcus. The lateral margins of the carapace are very strongly arcuate and unevenly serrate. There is a spine on the margin behind the

anterior branch of the cervical depression and one behind the posterior branch. On the carapace near the first spine there is a tubercle which in a smaller female is replaced by a spine: in a third and much smaller specimen this spine is but slightly indicated and the serrations and spines are inconspicuous.

The surface of the carapace is set with large, well-separated granules. The chelipeds are long, cylindrical, and free from spines, except at the articulations. The surfaces, however, have the same character of granulations as the carapace. The ambulatory legs are smooth: the dactyls have a row of short, horny teeth, which form a comb on the lower margin.

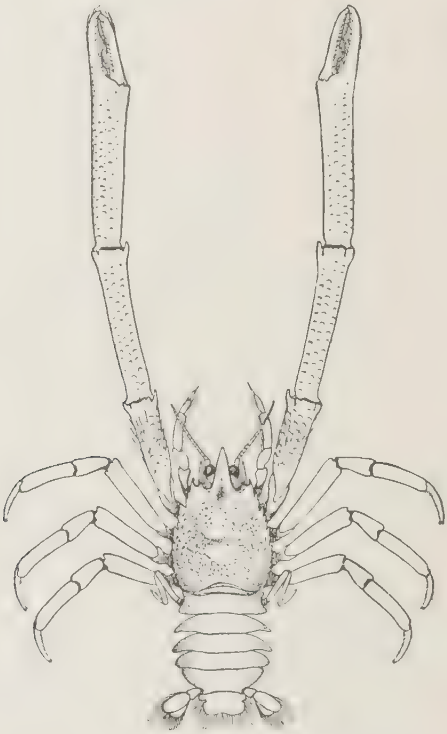

FIG. 37.—UROPTYCHUS GRANULATUS, × 1.

Length of carapace, 11 mm.; breadth between the antero-lateral angles, 7 mm.; a little behind the middle, 12 mm.; at the posterior margin, 10 mm.; length of chelipeds, 59 mm.; of the palm, 18 mm.; of the fingers, 8 mm.

Taken by the *Albatross* at station 2818 in 392 fathoms, Galapagos Islands. Three females, the two largest with eggs.

Type.—Cat. No. 20567 U.S.N.M.

UROPTYCHUS JAMAICENSIS, new species.

The rostrum is deeply excavated on the basal half of its surface; it is flat above and below. The surface of the carapace is moderately swollen; the lateral margins are arcuate, ending at the antero-lateral

angles in a small paired spine. The carapace is smooth, glabrous, and punctuate under a lens. The chelipeds are long; the carpus is much longer than the merus and equal to the palm; both merus and carpus are cylindrical; the palm is compressed; the fingers are less than one-half the length of the palm; the merus and carpus have a spine at each of the anterior condyles.

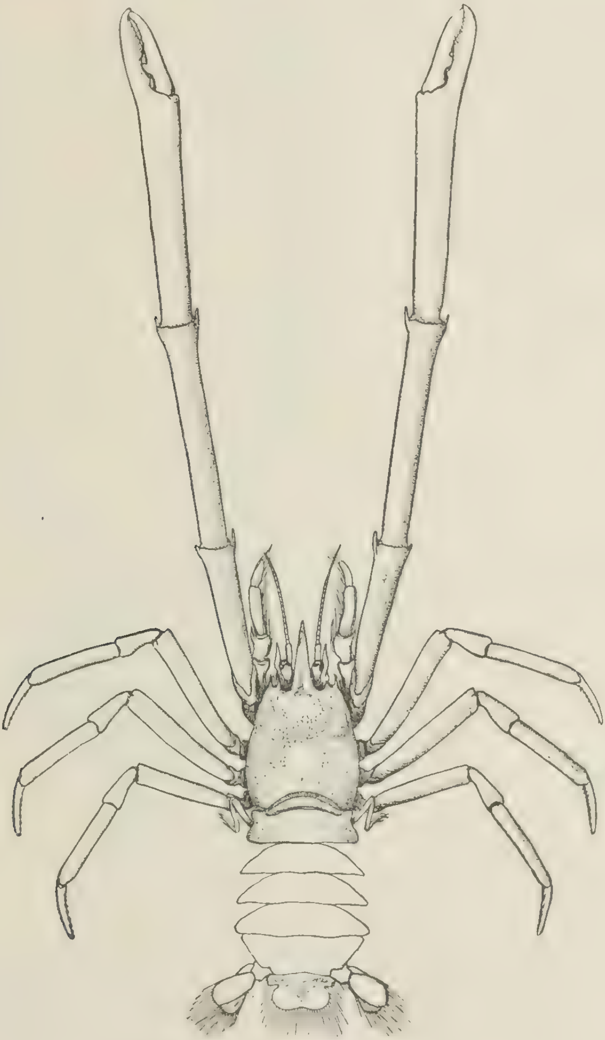

FIG. 38.—UROPTYCHUS JAMAICENSIS, × 1⅔.

Length of the carapace, 8 mm.; greatest breadth, 9 mm.; length of the rostrum from the margin behind the eyes, 5 mm.; breadth of rostrum at base, 2.5 mm.

Locality.—*Albatross* station 2117, in 683 fathoms, lat. 15° 24′ 40″ N., long. 63° 31′ 30″ W., Caribbean Sea.

Type.—Cat. No. 20568, U.S.N.M.

UROPTYCHUS MINUTUS, new species.

The rostrum is long, sharp, and broad at the base: the sides are straight. The carapace is broadest near the posterior margin: the lateral margins are armed with six or seven spinules, and converge to a narrow front. The species is remarkable for the large size of the hands. The palm is compressed; the immobile finger is longer than the dactyl, which closes inside of its hooked apex; there are several large spines on the merus and carpus. The propodal joints of the ambulatory legs have four or five long, slender spines on the lower margin.

FIG. 39.—UROPTYCHUS MINUTUS, × $3\frac{2}{3}$.

FIG. 40.—UROPTYCHUS PRINCEPS, × $1\frac{1}{3}$.

This is the smallest species examined. Length of carapace, 3 mm.; chelipeds, 10 mm.

Locality.—*Albatross* station 2120, in 73 fathoms, off Trinidad.

Type.—Cat. No. 7833, U.S.N.M.

UROPTYCHUS PRINCEPS, new species.

The rostrum is long, sharp pointed, broad at the base and curved downward; four or five small spines lie along its margins irregularly placed. The carapace is broader than long, flattened, armed on the margin with fine, long, slender spines. A row of spines extends across the carapace a little behind the front: the row is interrupted in the middle. There are numerous spinules on the carapace near the margins.

The upper distal angle of the merus of the maxillipeds is armed with a single spine: the corresponding angle of the following joint with two.

There are four lines of spines on the merus of the chelipeds: the spines near the distal margin are long: there are seven rows on the carpus: the palm is compressed and long: eleven spines on the crest and fifteen on the lower margin: a few spinules are placed on the outer surface near the carpus and crest: the inner surface is smooth.

The ambulatory legs have a single row of spines on the crest of the meral and carpal joints: the meral joints have two additional rows below.

The carapace is 12.5 mm. in length and 13.5 mm. broad. The rostrum is 5.5 mm. long; the chelipeds 55 mm. in length.

Locality.—*Albatross* station 2752, in 281 fathoms, lat. 13° 34′ 00″ N., long. 61° 04′ 00″ W., Lesser Antilles.

Type.—Cat. No. 20564, U.S.N.M.

UROPTYCHUS SCAMBUS, new species.

The rostrum is triangular, its apex reaches the base of the cornea. The front is cut back into semicircular orbits, which are continuous with the rostrum on the inside and nearly so with the finger-like projection at the antero-lateral angles which guard the outer angles of the orbital sinus. The carapace is broader than long, measuring 7 mm. in length to 8 mm. in breadth, it is convex in all directions, and has no marginal or other spines; the surface is glabrous; the sides are prolonged at the antero-lateral angles into finger-like processes, which do not suggest spines. In shape the carapace is triangular, with rounded posterior apices and the anterior apex cut off to make room for the eyes and other appendages.

FIG. 41.—UROPTYCHUS SCAMBUS, × 2½.

The merus of the maxillipeds is unarmed.

The elongated chelipeds are unarmed, with the exception of some slight projections at the distal margins of the merus and carpus and two tubercles in the gape of the fingers.

The ambulatory feet are cylindrical: the dactyls are subprehensile, and armed beneath with a row of little spines which are hidden by a dense growth of hair.

It will be seen by the figures that this species is very closely related to *Uroptychus brevis* of the Antillian region: the subprehensile dactyls common to both, in conjunction with the proportions of the carapace, might well enough warrant generic distinction, if the genus as at present constituted was overcrowded, which can hardly be claimed for it.

The type and only specimen is a female with eggs, dredged by the *Albatross* off Honshu Island, Japan, at station 3706, in 337 fathoms.

Type.—Cat. No. 26165, U.S.N.M.

UROPTYCHUS SCANDENS, new species.

The rostrum is about 1.2 mm. in length, narrow, pointed, concave above. The posterior line of the orbital sinus is but little behind the line of the antero-lateral angles. The eyes are cylindrical and about 1 mm. in length.

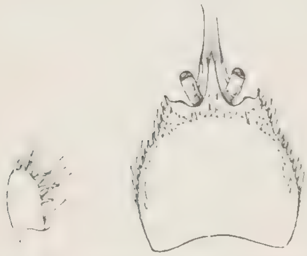

Fig. 42.—Uroptychus scandens. ×4.

The carapace is 4 mm. in length, measured from the orbit to the posterior margin at the median line and 4.5 mm. in breadth.

The lateral margins are spinulose; a few spinules are placed along the side of the gastric region, replaced on the front of the region by granules. The antero-lateral angles are armed with spines a little larger than those of the margin.

The chelipeds are long, slender, and altogether lacking in armature, with the exception of a tubercle on the prehensile edge of the movable finger; the opposing finger has a sulcus into which the tubercle nicely fits.

The dactyls of the ambulatory feet are short and blunt; a fringe of short sharp spines render them prehensile in no small degree. The carapace and legs are set with long fine hair.

The type and only specimen is a female, with eggs, dredged by the *Albatross* at station 3715, in 68–65 fathoms, off Honshu Island, Japan.

Type.—Cat. No. 26166, U.S.N.M.

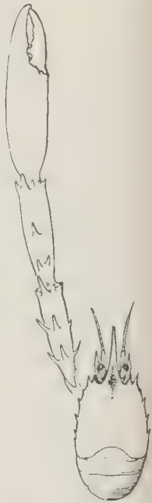

Fig. 43.—Uroptychus spiniger, × 2.

UROPTYCHUS SPINIGER, new species.

The rostrum is slender and sharp pointed, concave on the upper surface of the basal half. The antero-lateral angles of the carapace are marked by large and very sharp spines. The lateral margins are armed with spines of uneven size, the one behind the antero-lateral is small, followed by a large one, which in turn is followed by two much smaller ones.

The meral and carpal joints of the maxillipeds are each armed on the distal upper angle with a single spine. The coxa and ischium of the chelipeds are each armed with a single spine; the merus with six very stout spines, three in a transverse row on the proximal portion, two near the middle, and one on the distal margin; there are three or four on the surface of the carpus and four short conical spines on the border next the palm. The merus of the ambulatory legs has two spines on the upper border.

Length of carapace, 3.7 mm.; breadth, 4 mm.; length of rostrum, 3 mm.; length of chelipeds, 18 mm.

Locality.—*Albatross* station 2152, in 387 fathoms, off Habana.

Type.—Cat. No. 7795, U.S.N.M.

Genus PTYCHOGASTER A. Milne-Edwards.

PTYCHOGASTER DEFENSA, new species.

FIG. 41.—PTYCHOGASTER DEFENSA, × 1.

The rostrum is slender and styliform, about twice as long as the eyes. The gastric area is armed with seven slender spines similar to the rostrum in appearance, but somewhat shorter; one is placed in the center of the area and the others at equal intervals from it, forming a

circle; four spines on the cardiac area form a square; there are six paired spines on the branchial areas and one on the hepatic.

The first and second segments of the abdomen are each armed with a row of large spines; the third, fourth, and fifth segments have a large paired spine on the side with a smaller spine close behind it; the sixth segment has a group of about twelve spines. The spines of the legs are long, slender, and curved, numerous but not crowded.

This species is distinguished from *P. investigatoris* Alcock and Anderson by the larger size and lesser numbers of the spines on the chelipeds and ambulatory feet, and by the armature of the abdomen. The spines of the carapace seem to be a little longer in *P. defensa*, but in general the species are closely related.

Length of body from the margin behind the eyes to the end of the telson, 33 mm.; of the cheliped, 104 mm.; of the first ambulatory leg, 60 mm.

Locality.—*Albatross* station 2818, in 392 fathoms, Galapagos Islands.

Type.—Cat. No. 20563, U.S.N.M.

LIST OF KNOWN MARINE SPECIES OF GALATHEIDÆ.

GALATHEA ACANTHOMERA Stimpson.

Galathea acanthomera STIMPSON, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 252.

Bonin Islands, between coral, at a depth of 1 fathom.

GALATHEA ACULEATA Haswell.

Galathea aculeata HASWELL, Proc. Linn. Soc. New South Wales, VI, p. 761; Cat. Aust. Crust., 1882, p. 162.

GALATHEA AEGYPTIACA Paulson.

Galathea aegyptiaca PAULSON, Izsledovaniya Rakoobraznikh Krasnago Morya, I, Kief, 1875, p. 94, pl. XII, fig. 1–1b.

GALATHEA AFFINIS Ortmann.

Galathea affinis ORTMANN, Zool. Jahrb. System., p. 252, 1892, pl. II, fig. 9.

GALATHEA AGASSIZI A. Milne-Edwards.

Galathea agassizi A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 47.—A. MILNE-EDWARDS and E. L. BOUVIER, Ann. Sci. Nat. Zool., (7), XVI, 1894, p. 252; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 17, pl. I, figs. 6–15.

West India region.

GALATHEA ANDREWSI Kinahan.

Galathea andrewsi KINAHAN, Proc. Nat. Hist. Soc., Dublin, II, p. 58, pl. XVI, fig. 8.

Galathea intermedia BONNIER, Bull. Sci. France et Belg., (3), XIX, 1888, p. 130.

Specimens in the Museum can be distinguished from *G. intermedia* (see key, p. 247); the review is, however, incomplete

GALATHEA AUSTRALIENSIS Stimpson.

Galathea australiensis Stimpson, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 251.
Galathea australiensis Haswell, Cat. Aust. Crust., 1882, p. 161.

GALATHEA BREVIMANA Paulson.

Galathea brevimana Paulson, Izsledovaniya Rakoobraznikh Krasnago Morya, 1, Kief, 1875, p. 95.

GALATHEA CALIFORNIENSIS, new species, see p. 247.

GALATHEA CORALLICOLA Haswell.

Galathea corallicola Haswell, Cat. Aust. Crust., 1882, p. 162; Proc. Linn. Soc, New South Wales, VI, p. 761.

GALATHEA DEFLEXIFRONS Haswell.

Galathea deflexifrons Haswell, Proc. Linn. Soc. New South Wales, VI, p. 761; Cat. Aust. Crust., 1882, p. 163.

Albany Passage, among Comatulids.

GALATHEA DISPERSA Spence Bate.

Galathea dispersa Spence Bate, Jour. Proc. Linn. Soc. Lond., Zool., III, 1859, p. 3.—Bonnier, Bull. Scient. France et Belg., (3), XIX, 1888, p. 154, pl. xiii, figs. 1–3. (See for synonymy.)

GALATHEA ELEGANS Adams and White.

Galathea elegans Adams and White, Zool. Samarang, Crustacea, pl. xii, fig. 7.—Haswell, Cat. Aust. Crust., 1882, p. 163.

Holborn Island, 20 fathoms.

GALATHEA GIARDI Th. Barrois.

Galathea giardi Th. Barrois, Crust. Podopht. de Concarneau, 1882, p. 22; Cat. des Crust. Marins Recueillis aux Açores, 1888, p. 21, pl. ii, fig. 1.

GALATHEA GRANDIROSTRIS Stimpson.

Galathea grandirostris Stimpson, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 252.

Japan, Kagosima Bay, in 5 fathoms.

GALATHEA INCONSPICUA Henderson.

Galathea inconspicua Henderson, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 408; Voyage of the Challenger, XXVII, Anomura, 1888, p. 122, pl. xii.

GALATHEA INTEGRA, new species, see p. 248.

GALATHEA INTEGRIROSTRIS Dana.[a]

Galathea integrirostris Dana, U. S. Explor. Exped., Crust., 1858, p. 482, pl. xxx, fig. 12.

Dredged at Tahaina, Sandwich Islands.

[a] *Galathea integra* differs in that the rostrum is very much more acute in *integra* and the merus of the maxillipeds is short and broad, its inner margin armed with a large spine.

GALATHEA INTERMEDIA Lilljeborg.

Galathea intermedia LILLJEBORG, Öfvers. Vet. Akad. Forhandl., 1851, p. 21.
Galathea parroceli GOURRET, Décapod. Macrou. nouv. du Golfe de Marseilles, Compt. Rend. Acad., CV, 1887, p. 1034.
Galathea intermedia BONNIER, Bull. Scient. France et Belg., (3), XIX, 1888, p. 130.

Bonnier makes *G. andrewsi* a synonym of this species. Of the correctness of this I do not feel at all sure.

GALATHEA LABIDOLEPTA Stimpson.

Galathea labidolepta STIMPSON, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 251.

Cape of Good Hope.

GALATHEA LATIROSTRIS Dana.

Galathea latirostris DANA, U. S. Explor. Exped., Crust., 1858, p. 480, pl. XXX, fig. 8.

Fiji Islands. Among corals and in cavities of the coral rock. Nearly colorless.

GALATHEA LONGIMANA Paulson.

Galathea longimana PAULSON, Izsledovaniya Rakoobraznikh Krasnago Morya, I, Kief, 1875, p. 94, pl. XII, fig. 2–2a.

GALATHEA LONGIROSTRIS Dana.

Galathea longirostris DANA, U. S. Explor. Exped., Crust., p. 482, pl. XXX, fig. 11.

Fiji Islands. Brought up on a comatula from a depth of 10 fathoms.

GALATHEA MACHADOI Th. Barrois.

Galathea machadoi BARROIS, Cat. des Crust. Marins Recueillis aux Açores, 1888, p. 22, pl. II, fig. 2–10.—A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., (7), XVI, 1894, p. 252.

GALATHEA MAGNIFICA Haswell.

Galathea magnifica HASWELL, Proc. Linn. Soc. New South Wales, VI, p. 761; Cat. Aust. Crust., p. 162.

GALATHEA NEXA Embleton.

Galathea nexa EMBLETON, Proc. Berwick. Nat. Field Club.—BONNIER, Bull. Scient. France et Belg., (3), XIX, p. 149, pl. XII, figs. 6, 8. (See for synonymy.)

GALATHEA ORIENTALIS Stimpson.

Galathea orientalis STIMPSON, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 252.—ORTMANN, Zool. Jahrb. Syst., 1892, p. 252, pl. II, fig. 10.

In the Strait of Lyimoon near Hongkong, in 25 fathoms.

GALATHEA PAUCI-LINEATA, new species, see p. 249.

GALATHEA PUBESCENS Stimpson.

Galathea pubescens STIMPSON, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 252.

Japan, in the port of Hakodadi, and at the island of Ousima, in 25 to 35 fathoms.

GALATHEA PUSILLA Henderson.

Galathea pusilla HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 407; Voyage of the Challenger, XXVII, 1888, p. 121, pl. XII, fig. 1.

Off Twofold Bay, Australia, in 150 fathoms.

GALATHEA ROSTRATA A. Milne-Edwards.

Galathea rostrata A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 47.—A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., (7), XVI, 1894, p. 252; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 14, pl. I, figs. 1–5.

West India region.

GALATHEA RUFIPES Edwards and Bouvier.

Galathea rufipes A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat. Zool., (7), XVI, 1894, p. 252; Exped. Scient. du Travailleur et du Talisman, Brachy. et Anom., 1890, p. 280, pl. XXIX, figs. 4–8.

Cape Verde Islands.

GALATHEA SPINOSOROSTRIS Dana.

Galathea spinosorostris DANA, U. S. Explor. Exped. Crust., 1858, p. 480, pl. XXX, fig. 9a.

Sandwich Islands.

GALATHEA SQUAMIFERA Leach.

Galathea squamifera LEACH, Edin. Encycl., VII, p. 398.

Galathea fabricii LEACH, Encycl. Brit. Supp., pl. XXI.

Galathea squamifera LEACH, Malacostraca Podophthalmata Britaniæ, 1815, pl. XXVIII A., fig. 1.—BONNIER, Bull. Scient. France et Belg., (3), XIX, 1888, p. 143, pl. XII, figs. 1–5. (For synonymy see this.)

Northern Europe.

GALATHEA STRIGOSA Linnæus.

Cancer strigosus LINNÆUS Syst. Nat., 12th ed., 1766, p. 1052, No. 69.

Astacus strigosus PENNANT, Brit. Zool., 1777, pl. XIV, fig. 26.

Galathea strigosa FABRICIUS, Ent. Syst. Suppl., 1798, p. 414.—BONNIER, Bull. Scient. France et Belg., (3), XIX, 1888, p. 160, pl. XXIII, figs. 4–6 (synonymy).

Northern Europe.

GALATHEA SUBSQUAMATA Stimpson.

Galathea subsquamata STIMPSON, Proc. Acad. Nat. Sci. Phila., X, 1858, p. 252.

Island of Ousima.

GALATHEA VITIENSIS Dana.

Galathea vitiensis DANA, U. S. Explor. Exped. Crust., 1858, p. 481, pl. XXX, fig. 10a.

Fijis, about corals. Length, one-fourth of an inch, nearly colorless.

GALACANTHA.

GALACANTHA CAMELUS Ortmann.

Galacantha camelus ORTMANN, Zool. Jahrb. Syst., p. 257, 1892, pl. II, fig. 14.

GALACANTHA DIOMEDEÆ Faxon.

Galacantha diomedeæ FAXON, Bull. Mus. Comp. Zool., 1893, p. 180; Mem. Mus. Comp. Zool., XVIII, 1895, p. 79, pl. XXV, fix. 1.

GALACANTHA FAXONI, new name.

Galacantha rostrata FAXON, Bull. Mus. Comp. Zool., VIII, 1880, p. 52; Mem. Mus. Comp. Zool., XVIII, 1895, p. 78, pl. B, figs. 1, 1a.

The differences which in my opinion separate this species from *C. rostrata* of the West Indian region were clearly seen by Mr. Faxon. He had before him seven specimens from stations 3362, 3400, and 3414. His conclusions were that "The *Albatross* specimens differ constantly from the typical West Indian form in the following particulars: The spines at the antero-lateral angles of the carapace are more divergent, the anterior spine being more nearly parallel with the axis of the body; the posterior spine is relatively longer; the abdomen is smoother toward the central part of the segments; the dorsal spine of the fourth abdominal segment is smaller. In other regards there is considerable variation among different individuals."

GALACANTHA INVESTIGATORIS Alcock and Anderson.

Galacantha investigatoris ALCOCK and ANDERSON, Jour. Asiat. Soc. Bengal, LXIII, 1894, p. 173.—ALCOCK, Illus. Zool. Investigator, Crustacea, 1895, pl. XII, fig. 4.

Galacantha rostrata var. investigatoris ALCOCK, Cat. Indian Deep-Sea Crust. Indian Museum, 1901, p. 276.

Arabian Sea, off the Island of Minicoy, 1,200 fathoms.

GALACANTHA ROSTRATA A. Milne-Edwards.

Galacantha rostrata A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., 1880, VIII, p. 52.—S. I. SMITH, Bull. Mus. Comp. Zool., X, 1882, p. 21, pl. IX, fig. 2; Ann. Report U. S. Fish Com. for 1882, 1884, p. 355.—A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat. Zool., (7), XVI, 1894, p. 271.—FAXON, Mem. Mus. Comp. Zool., XVIII, 1895, p. 78, pl. B, figs. 1, 1a; Mem. Mus. Comp. Zool., XIX, No. 2, 1897, p. 60, pl. IV, figs. 21–24.

Galacantha talismani H. FILHOL, La Vie au Fond des Mers, 1884, pl. III.—ED. PERIER, Les Explorations Sous-Marines, 1885, fig. 8, p. 341.—HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 167, pl. XX, fig. 1.

Galacantha bellis HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 167, pl. XIX, fig. 6.

Galacantha areolata WOOD-MASON, Ann. Mag. Nat. Hist., 1891, p. 200.

Munidopsis rostrata S. I. Smith, Proc. U. S. National Museum, VII, 1885, p. 493; Report of the U. S. Fish Com. for 1885, 1886, p. 45, pl. vi, fig. 1.
Galacantha rostrata Alcock, Cat. Indian Deep-Sea Crust., 1901, p. 275.

Western Europe and West Indies.

GALACANTHA SPINOSA A. Milne-Edwards.

Galacantha spinosa A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 53.—A. Milne-Edwards and E. L. Bouvier, Ann. des Sci. Nat. Zool., (7), XVI, 1894, p. 270; Mem. Mus. Comp. Zool., XIX, 1897, p. 56, pl. iv, figs. 15–20.

GALACANTHA TRACHYNOTUS Anderson.

Galacantha trachynotus Anderson, Jour. Asiat. Soc. Bengal, LXV, 1896, p. 100.—Alcock, Illus. Zool. Investigator, Crustacea, 1896, pl. xxv, fig. 3.
Galacantha spinosa var. *trachynotus* Alcock, Cat. Indian Deep-Sea Crust., Indian Museum, 1901, p. 277.

Arabian Sea, 912–931, and 947 fathoms.

PLEURONCODES Stimpson.

PLEURONCODES MONODON (M. Edwards.)?

?*Galathea monodon* M. Edwards, Hist. Nat. Crust., II, 1837, p. 276.
?*Pleuroncodes monodon* Stimpson, Ann. Lyc. Nat. N. Y., VII, 1860, p. 245.—Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, p. 176; Mem. Mus. Comp. Zool., XVIII, 1895, p. 72, pl. xv, fig. 3.

PLEURONCODES PLANIPES Stimpson.

Pleuroncodes planipes Stimpson, Ann. Lyc. Nat. Hist. N. Y., VII, April, 1860, p. 245.

CERVIMUNIDA, new genus, see p. 249.

CERVIMUNIDA PRINCEPS, new species, see p. 249.

MUNIDA Leach.

Munida Leach, Dict. Sci. Nat., XVIII, 1820, p. 52.

MUNIDA AFFINIS A. Milne-Edwards.

Munida affinis A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 48.—A. Milne-Edwards and Bouvier, Ann. des Sci. Nat. Zool., (7), XVI, 1894, p. 257; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 53, pl. iii, fig. 14.
Munida affinis Benedict, The Anomuran Collections made by the Fish Hawk Expedition to Porto Rico, U. S. Fish Commission Bull. for 1900, p. 147.

This species was taken off Habana at stations 2169 in 78 fathoms, 2321 in 230 fathoms, 2329 in 118 fathoms, 2346 in 200 fathoms. Off the south coast of Cuba at stations 2129 in 274 fathoms, 2130 in 175 fathoms, 2131 in 202 fathoms, 2133 in 290 fathoms, 2135 in 250 fathoms. Off the west end of Cuba at station 2350 in 250 fathoms. One lot is labeled station 2138 in 23 fathoms off the east end of

Jamaica. It is possible that some mistake has been made in this station number, as this species did not occur in other shallow-water dredging.

MUNIDA ANDAMANICA Alcock.

Munida militaris var. andamanica ALCOCK, Ann. and Mag. Nat. Hist., (6), XIII, 1894, p. 321; Illus. Zool. of Investigator Crust., 1895, pl. XIII, fig. 2; Desc. Cat. Indian Deepsea Crust., Indian Museum, p. 242.

"From the Andaman Sea." "173–419 fathoms, and from the Arabian Sea, in the neighborhood of the Laccadives and Maldives, 210–360 fathoms."

MUNIDA ANGULATA, new species, see p. 252.

MUNIDA AUSTRALIENSIS Henderson.

Munida subrugosa var. australiensis HENDERSON, Challenger Report, XXVII, 1888, p. 125, pl. XIII, fig. 3.

The characters given by Mr. Henderson are sufficient for specific rank in the absence of intergrading forms.

Challenger station 162 off East Moncoeur Island, Bass Strait; depth 38 to 40 fathoms. Several specimens, the majority of which are females; the body of the largest measures only 25 mm. in length.

MUNIDA BAMFFICA (Pennant).

Astacus bamfficus PENNANT, Brit. Zool., IV, 1777, pl. XIII, fig. 25.

Galathea rugosa FABRICIUS, Ent. Syst., II, 1798, p. 472; Suppl., p. 415.

Galathea longipeda LAMARCK, Syst. des Anim. sans vert., 1808, p. 128.

Munida rondeletii GORDON, The Zoologist, X, 1852, p. 3678, London.

Munida bamffia NORMAN, Report on Dredgings, Shetland, 1868, p. 265.

Munida tenuimana G. O. SARS, Vidensk. Selsk. Forhand. Christ., 1871, p. 257.

Munida bamffia BONNIER, Bull. Sci. France et Belg., (3), XIX, 1888, p. 164, pl. XIII, figs. 7 and 8.

Munida bamffica A. MILNE-EDWARDS and E. L. BOUVIER, Crustaces Decapodes provenant des campagnes du yacht l'Hirondelle (1886, 1887, 1888), Pt. 1, Brachyures et Anomoures, Res. Camp. Scient., Albert, I, Pt. 7, 1894, p. 83, pl. VII, fig. 1–7; Pt. 12, XIII, 1899, p. 75, pl. IV, figs. 6–16, Monaco.

The ten figures in the last work referred to show the variations of this species. From this work and that of J. Bonnier full synonymy and reference can be made out.

European waters.

MUNIDA CARIBÆA Stimpson.

Munida caribæa STIMPSON, Ann. Lyc. Nat. Hist. New York, VII, 1860, p. 244.

Dr. Faxon says of this: "The specimens doubtfully referred to, *Munida caribæa* Stimpson, by Prof. S. I. Smith are *Munida iris* of Milne-Edwards. Stimpson's *Munida caribæa* is absolutely indeterminable from his brief notice of it, and the types were burned in the great Chicago fire. The name *caribæa* should then be dropped and Milne-Edwards's *iris* and *irrasa* should be retained."[a]

[a] Mem. Mus. Comp. Zool., XVIII, 1895, p. 73.

MUNIDA COMORINA Alcock and Anderson.

Munida comorina Alcock and Anderson, Ann. and Mag. Nat. Hist., (7), III, 1899, p. 18; Illus. Zool. Invest. Crust., pl. xliii, fig. 3.

MUNIDA CONSTRICTA A. Milne-Edwards.

Munida constricta A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 52.—A. Milne-Edwards and Bouvier, Ann. Sci. Nat. Zool., (7), XVI, 1894, p. 256; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 40, pl. iii, fig. 5.

West India region.

MUNIDA CURVATURA, new species, see p. 253.

MUNIDA CURVIMANA Edwards and Bouvier.

Munida curvimana A. Milne-Edwards and E. L. Bouvier, Ann. des Sci. Nat. Zool., 1894, (7), XVI, p. 256; Exped. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 287, pl. xxix, fig. 12–16.

MUNIDA CURVIPES, new species, see p. 254.

MUNIDA CURVIROSTRIS Henderson.

Munida curvirostris Henderson, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 412.
Munida militaris var. *curvirostris* Henderson, Challenger Report, XXVII, 1888, p. 139, pl. iii, fig. 7.

Habitat.—Station 200, off Sibago, Philippines; depth, 250 fathoms; bottom, green mud. An adult male measuring 25 mm. in length (not including the rostrum). Station 210, off Zebu, Philippines; depth, 375 fathoms; bottom, blue mud. An adult female measuring 20 mm. in length.

MUNIDA DEBILIS, new species, see p. 256.

MUNIDA DECORA, new species, see p. 257.

MUNIDA EDWARDSII Miers.

Munida edwardsii Miers, Alert Crustacea, 1884, p. 560, pl. li, fig. A.

MUNIDA EVERMANNI Benedict.

Munida evermanni Benedict, Anomuran Collections made by the Fish Hawk Expedition to Porto Rico, 1901, p. 146, pl. v, fig 4.

MUNIDA FLINTI, new species, see p. 258.

European seas.

MUNIDA FORCEPS A. Milne-Edwards.

Munida forceps A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 49.—Perrier, Les Explorations Sous Marines, fig. 109, p. 220.—A. Milne-Edwards and Bouvier, Ann. des Sci. Nat. Zool., (7), XVI, 1894, p. 256; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 28, pl. ii, fig. 8.

West Indian region.

MUNIDA GRACILIPES Faxon.

Munida gracilipes FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 179; Mem. Mus. Comp. Zool., XVIII, 1895, p. 77, pl. XVI, figs. 2–2b.

Gulf of Panama.

MUNIDA GRACILIS Henderson.

Munida gracilis HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 412; Challenger Report, XXVII, 1888, Anomura, p. 143, pl. XIV, fig. 4.

Challenger station 166; depth, 275 fathoms, west of New Zealand. Two specimens.

MUNIDA GRANULATA Henderson.

Munida granulata HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 409; Challenger Report, XXVII, 1888, Anomura, p. 133, pl. XIV, fig. 3.

Challenger station 173; depth, 315 fathoms, off Fiji Islands. Nine specimens.

Henderson says of this (page 134): "The second and third abdominal segments bear six spinules each, four of which are arranged on the anterior and two near the posterior margin; the third segment bears five spinules, a mesial one being present on the posterior margin, which is somewhat prominent." Did he not mean third armed segment rather than third segment, which he had just described? His figure shows spines on the second segment only.

MUNIDA GREGARIA (Fabricius).

Galathea gregaria FABRICIUS, Ent. Syst., II, 1793, p. 473.

Grimothea gregaria LEACH, Dict. d. Sci. Nat., XVIII, 1820, p. 50.—DANA, U. S. Expl. Expd. Crust., XIII, 1852, Crust., Pt. 1, p. 483, pl. XXXI, fig. 1.

Grimothea novæ zelandiæ FILHOL, Passage de Venus, Mission de l'Ile Campbell, 1874, p. 426. (Institute de France.)

Munida gregaria MIERS, Proc. Zool. Soc. London, 1881, p. 73.

Munida subrugosa HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 124.

Munida gregaria A. MILNE-EDWARDS, Mission Scient. du Cap Horn, Crust., 1891, p. F. 32, pl. II, fig. 1.

Guérin's figure of "*Grimotea gregaria*"[a] shows eyestalks as long as those of the New Zealand specimen, but it seems to have little else in common. A. Milne-Edwards has given the best account of the differences separating this species from *M. subrugosa* and has shown in a good figure the differences observed between its own adult and immature forms. In my opinion the question of the identity of the Cape Horn species with that from New Zealand remains yet an open question, which can only be settled by comparison of a large series of specimens from both localities.

The young of *Munida gregaria* differ more from the adult than is the case with the young of any other species represented in the col-

[a] Guérin, Voyage de la Coquille, II, Pt. 2, 1830, p. 32; Atlas, pl. III, fig. 1.

lection. In three specimens from New Zealand, the rostrum is only a little longer than the eyes and the supraocular spines are very short and much more divergent than in the adults. The eyestalks are proportionately longer than in any species of the genus in the collection. In alcohol the eyes are transverse in direction and extend beyond the line of the sides by about one-half of the diameter of the cornea. The antero-lateral angles are rounded in the young, in sharp contrast with the angles of the adult, which are armed with a large double spine, giving it an angular appearance. The carapace in the young has the two spines on the gastric area behind the supra-ocular spines and a very small paired spine in line with these. The posterior margin of the cervical suture is armed with four spines. In addition to these spines in the adult there are about eight spines on the first ciliated line behind the gastric pair and another pair posterior to these. The armature of the abdomen is the same in both forms; the maxillipeds are similar, but longer in the young.

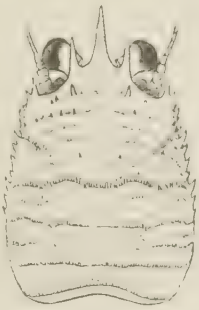

FIG. 45.—MUNIDA GREGARIA, × 1.

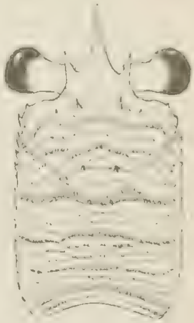

FIG. 46.—MUNIDA GREGARIA, YOUNG, × 2½.

The three specimens from New Zealand range about 45 mm. in length while numerous specimens of the adult from the Straits of Magellan range from 110 to 115 mm. Younger specimens may vary much more from the adult form.

MUNIDA HASWELLI Henderson.

Munida haswelli HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 411; Challenger Report, XXVII, Anomura, p. 139, pl. III, fig. 5.

Challenger station 163A, depth 150 fathoms, off Twofold Bay, Australia. One male and three young.

MUNIDA HETERACANTHA Ortmann.

Munida heteracantha ORTMANN, Zool. Jahrb., VI, 1892, p. 255, pl. II, fig. 12.

Japan.

MUNIDA HISPIDA, new species, see p. 259.

MUNIDA HONSHUENSIS, new species, see p. 261.

MUNIDA INCERTA Henderson.

Munida incerta HENDERSON, Challenger Report, XXVII, 1888, p. 130, pl. XIII, fig. 4.

Challenger station 200, depth 250 fathoms, off Sibago Island, Philippines. One imperfect specimen.

MUNIDA INORNATA Henderson.

Munida inornata HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 411; Challenger Report, XXVII, Anomura, 1885, p. 140, pl. XVI, fig. 6.

Challenger station 219, depth 150 fathoms, north of New Guinea. One specimen.

MUNIDA IRIS A. Milne-Edwards.

Munida iris A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 49.—A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zoöl., (7), XVI, 1894, p. 256; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 21, pl. II, figs. 2–7.

Munida caribæa? S. I. SMITH, Proc. U. S. Nat. Mus., III, 1881, p. 428; VI, 1883, p. 40, pl. III, fig. 11; Report U. S. Fish Commissioner for 1882, 1884, p. 255, and Report for 1885, 1886, p. 39.

Munida, species indt. S. I. SMITH, Bull. Mus. Comp. Zool., X, 1882, p. 22, pl. x.

Off the eastern coast of the United States. *Albatross* station 2420 in a depth of 47 fathoms, and at numerous other stations. A very abundant species.

MUNIDA IRRASA A. Milne-Edwards.

Munida irrasa A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 49.

Munida caribæa A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 49.—A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 256; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 25, pl. I, figs. 16–20; pl. II, fig. 1.

Southeastern coast of the United States and West India region.

MUNIDA JAPONICA Stimpson.

Munida japonica STIMPSON, Proc. Acad. Nat. Sci. Phil., X, 1858, p. 252.—ORTMANN, Crustacea of the Semon Collection, 1894, p. 24; Jena.—MIERS, Proc. Zool. Soc. Lond., 1879, p. 51.

In Kagoshima Bay, Japan, in 20 fathoms.

MUNIDA LONGIPES A. Milne-Edwards.

Munida longipes A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 50.—A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 257; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 44, pl. III, figs. 9–13.

West India region.

MUNIDA MEDIA, new species, see p. 262.

MUNIDA MEXICANA, new species, see p. 264.

MUNIDA MICROPHTHALMA A. Milne-Edwards.

Munida microphthalma A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., 1880, VIII, p. 51.—HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 127, pl. III, fig. 4.

Munida microphthalma (A. M. Edwards?) Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, p. 179; Mem. Mus. Comp. Zool., XVIII, 1895, p. 78.—A. Milne-Edwards and Bouvier, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 256; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 32, pl. ii, figs. 9–13.

West India region.

MUNIDA MICROPS Alcock.

Munida microps Alcock, Ann. and Mag. Nat. Hist., (6), XIII, 1894, p. 326; Illus. Zool. Investigator, Crust., 1895, pl. xiii, fig. 5; Desc. Cat. of Indian Deep-Sea Crust., Macrura and Anomalia, in the Indian Museum, 1901, p. 240.

MUNIDA MICROPS var. LASIOCHELES Alcock.

Munida microps var. *lasiocheles* Alcock, Ann. and Mag. Nat. Hist., (6), XIII, p. 327; Illus. Zool. Investigator, Crust., 1895, pl. xiii, fig. 8; Desc. Cat. of Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 241.

MUNIDA MILES A. Milne-Edwards.

Munida miles A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 51.—Henderson, Challenger Report, XXVII, 1888, Anomura, p. 126.—A. Milne-Edwards and Bouvier, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 256; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 35, pl. iii, figs. 1–4.

West India region.

MUNIDA MILITARIS Henderson.

Munida militaris Henderson, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 410; Challenger Report, XXVII, 1888, Anomura, p. 137, pl. xiv, figs. 2, 5.

Munida vitiensis Henderson, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 410.

Challenger station 173, depth 315 fathoms, off Matuku. Station 192, depth 140 fathoms, off Little Ki Island. Amboina, 100 fathoms.

MUNIDA NORMANI Henderson.

Munida normani Henderson, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 408; Challenger Report, XXVII, 1888, Anomura, p. 129, pl. xiii, fig 5.

Challenger station 173, off Matuku, Fiji Islands; depth, 315 fathoms.

MUNIDA NUDA, new species, see p. 265.

MUNIDA OBESA Faxon.

Munida obesa Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, p. 176; Mem. Mus. Comp. Zool., XVIII, 1895, p. 73, pl. xvi, figs. 1, 1a.

Gulf of Panama; station 3355 in 182 fathoms and station 3389 in 210 fathoms.

MUNIDA PERARMATA Edwards and Bouvier.

Munida perarmata A. Milne-Edwards and Bouvier, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 257; Résult. des Camp. Scient. de l'Hirondelle (Supp.) et de la Princesse-Alice, Pt. 13, 1899, p. 81; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 305, pl. xxx, fig. 1.

European waters.

MUNIDA PERLATA, new species, see p. 266.

MUNIDA PROPINQUA Faxon.

Munida propinqua FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 178; Mem. Mus. Comp. Zool., XVIII, 1895, p. 76, pl. XVIII, figs. 1, 1a.

Gulf of Panama and near the Galapagos Islands, 385 to 511 fathoms.

MUNIDA PROXIMA Henderson.

Munida proxima HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 410; Challenger Report, XXVII, 1888, Anomura, p. 135, pl. XIII, fig. 2.

Challenger station 219, north of New Guinea: depth 150 fathoms. Three adult specimens, one with ova.

MUNIDA PUSILLA, new species, see p. 268.

MUNIDA QUADRISPINA, new species, see p. 269.

MUNIDA REFULGENS Faxon.

Munida refulgens FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 177; Mem. Mus. Comp. Zool., XVIII, 1895, p. 75, pl. XVII.

Off Cocos Island, off coast of Ecuador, and near Tres Marias Islands: depth 42 to 112 fathoms. Sixty-seven specimens.

MUNIDA ROBUSTA A. Milne-Edwards.

Munida robusta A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 48.—A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 256; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 42, pl. III, figs. 6–8.

West India region.

MUNIDA SANCTI-PAULI Henderson.

Munida sancti-pauli HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 411; Challenger Report, XXVII, 1885, Anomura, p. 142, pl. III, fig. 6.

St. Paul's rocks: depth 10 to 60 fathoms. A female with ova and a young male.

MUNIDA SCABRA Henderson.

Munida scabra HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 409; Challenger Report, XXVII, 1888, Anomura, p. 134, pl. XV, fig. 1.

Station 192, off Little Ki Island: depth 140 fathoms. Fifteen specimens.

MUNIDA SCULPTA, new species, see p. 270.

MUNIDA SEMONI Ortmann.

Munida semoni ORTMANN, Crustacea of the Semon Collection, Jena, 1894, p. 24.

MUNIDA SIMPLEX, new species, see p. 272.

MUNIDA SPINICORDATA Henderson.

Munida spinicordata HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 413; Challenger Report, XXVII, 1888, Anomura, p. 146, pl. XV, fig. 3.

Challenger station 174d, off Kandavu, Fiji; depth 210 fathoms. A male specimen.

MUNIDA SPINIFRONS Henderson.

Munida spinifrons HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 412; Challenger Report, XXVII, 1888, Anomura, p. 144, pl. XV, fig. 1.

Challenger station 113a, anchorage off Fernando Noronha; depth 7 to 25 fathoms. A single specimen.

MUNIDA SPINOSA Henderson.

Munida spinosa HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 408; Voyage of the Challenger, XXVII, 1888, Anomura, p. 128, pl. III, fig. 3.

Challenger station 320, off Rio de la Plata; depth 600 fathoms; bottom green sand. Several specimens, the majority of which are young.

MUNIDA SPINULIFERA Miers.

Munida spinulifera MIERS, Crustacea in Zool. H. M. S. Alert, 1884, p. 279, pl. XXXI, fig. A.—HENDERSON, Challenger Report, XXVII, 1888, p. 128.

Arafura Sea, 32 to 36 fathoms.

MUNIDA SQUAMOSA Henderson.

Munida squamosa HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 409; Challenger Report, XXVII, 1888, p. 131, pl. XIII, fig. 1.

Challenger station 219, north of New Guinea; depth 150 fathoms.

MUNIDA SQUAMOSA var. PROLIXA Alcock.

Munida squamosa var. prolixa ALCOCK, Ann. and Mag. Nat. Hist., (6), XIII, 1894, p. 322; Illus. Investigator Crust., 1895, pl. XIII, fig. 3; Des. Cat. of the Indian Deep-Sea Crust., 1901, p. 244.

MUNIDA STIMPSONI A. Milne-Edwards.

Munida stimpsoni A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 47.—HENDERSON, Challenger Report, XXVII, 1888, p. 126, pl. XIV, fig. 1.—A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 257; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 48, pl. IV, figs. 1–13.—BENEDICT, Anomuran collection made by the Fish Hawk Expedition to Porto Rico, 1901, p. 147, in U. S. Fish Commission Bulletin for 1900.

West India region.

MUNIDA SUBRUGOSA Dana.

Munida subrugosa DANA, U. S. Exploring Expedition, XIII, 1852, Crust., p. 479, pl. XXX, fig. 7.—MIERS, Zool. Erebus and Terror, Crust., 1874, p. 3, pl. III, fig. 2; Cat. New Zealand Crust., 1876, p. 68.—TARGIONI TOZZETTI, Crust. Magenta, 1877, p. 234, pl. XIII, fig. 5.

Galathea subrugosa CUNNINGHAM, Trans. Linn. Soc. Lond., (Zool.), XXVII, 1871, p. 495.

Munida subrugosa A. MILNE-EDWARDS, Mission Scient. du Cap Horn, Crust., 1891, p. F. 36, pl. II, fig. 2.

MUNIDA TENELLA, new species, see p. 274.

MUNIDA TRICARINATA Alcock.

Munida tricarinata ALCOCK, Ann. and Mag. Nat. Hist., (6), XIII, 1894, p. 324; Illustrations of the Investigator Crustacea, 1895, pl. XII, fig. 1; Descriptive Catalogue of the Indian Deep-Sea Crustacea in the Indian Museum, 1901, p. 246.

Andaman Sea, 112 fathoms; Arabian Sea, off the N. Maldive Atoll, 210 fathoms.

MUNIDA TROPICALIS Edwards and Bouvier.

Munida tropicalis A. MILNE-EDWARDS and E. L. BOUVIER, Bull. Mus. of Nat. Hist., III, 1897, p. 364; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 286, pl. XXIX, figs. 9–11.

La Praya, 75 to 127 fathoms.

MUNIDA TUBERCULATA Henderson.

Munida tuberculata HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1895, p. 413; Challenger Report, XXVII, 1888, Anomura, p. 145, pl. XV, fig. 2.

Challenger station 173, 315 fathoms, off Matuku, Fiji Islands. Two specimens.

MUNIDA VALIDA S. I. Smith.

Munida valida S. I. SMITH, Proc. U. S. National Museum, VI, 1883, p. 42, pl. I.

Henderson in the *Challenger* Anomura, page 126, makes this species identical with *M. miles*. A. Milne-Edwards and E. L. Bouvier[a] make it distinct. Several fine specimens in the Museum collection bear out the latter view.

MUNIDA VIGILIARUM Alcock.

Munida vigiliarum ALCOCK, Des. Cat. of the Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 243.

[a] Ann. des. Sci. Nat., Zool., (7), XVI, 1894, p. 256.

MUNIDOPSIS Whiteaves.

Munidopsis WHITEAVES, Amer. Jour. Arts and Sci., 3d ser., VII, 1874, p. 212.

MUNIDOPSIS ABBREVIATA (A. Milne-Edwards).

Galathodes abbreviatus A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 55.

Munidopsis abbreviata A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 91, pl. v, fig. 1.

Blake station 195, in 502 fathoms; Martinique. Stations 161 and 162, in 583 and 734 fathoms; Guadeloupe.

MUNIDOPSIS ABDOMINALIS (A. Milne-Edwards).

Elasmonotus abdominalis A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 61.—A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 282; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 101, pl. VIII, figs. 7–10.

Blake station 291, in 200 fathoms, Barbados.

MUNIDOPSIS ABYSSORUM (Edwards and Bouvier).

Munidopsis abyssorum A. MILNE-EDWARDS and E. L. BOUVIER, Bull. Mus. Nat. Hist., III, 1897, p. 365; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 319, pl. XXX, figs. 15–19.

European waters.

MUNIDOPSIS ACULEATA Henderson.

Munidopsis subsquamosa var. aculeata HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 153, pl. XVI, fig. 1.

Munidopsis subsquamosa aculeata FAXON, Mem. Mus. Comp. Zool., XVIII, 1895, p. 86.

Challenger station 146, depth 1,375 fathoms, between Marion Island and the Crozets, a single specimen; also station 302, depth 1,450 fathoms, west of Patagonia.

MUNIDOPSIS ACUMINATA, new species, see p. 277.

MUNIDOPSIS ACUTA (A. Milne-Edwards).

Galathodes acutus A. MILNE-EDWARDS, Comp. Rend. Acad. des Sci., 1881, p. 932.

Munidopsis acuta A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 230; Expéd. Scient. du Travailleur et du Talisman, 1900, p. 312, pl. XXX, figs. 2–4.

MUNIDOPSIS ACUTISPINA, new name.

Munidopsis aculeata A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, p. 275; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 327, pl. XXXI, figs. 1–4.

A new name is necessary as *aculeata* was used by Henderson in the *Challenger* Anomura. See under *aculeata*, above.

MUNIDOPSIS AGASSIZII Faxon.

Munidopsis agassizii FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 182; Mem. Mus. Comp. Zool., XVIII, 1895, p. 88, pl. XVIII, figs. 4–4a.

Albatross station 3389, depth 210 fathoms, Gulf of Panama.

MUNIDOPSIS ANTONII (A. Milne-Edwards).

Galathodes antonii A. MILNE-EDWARDS in Filhol, La Nature, XII, 1884, p. 231, fig. 2.

Munidopsis antonii HENDERSON, Voyage of the Challenger, XXVII, 1888, Anomura, p. 151, pl. XVIII, fig. 1.

Munidopsis antoni A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat. Zool., (7), XVI, 1894, p. 275; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 321, pl. IV, fig. 2; pl. XXX, figs. 20–24.

MUNIDOPSIS ARIES (A. Milne-Edwards).

Orophorhynchus aries A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880. p. 58.—A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 287; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 111, pl. IX, figs. 7-11; pl. X, figs. 1, 2.

Blake station 236, in 1,591 fathoms, west India region.

MUNIDOPSIS ARIETINA Alcock and Anderson.

Munidopsis arietina ALCOCK and ANDERSON, Jour. Asiatic Soc. Bengal, XLIII, Pt. 2, 1894, p. 171; Illus. Zool. Investigator, Crust., 1895, pl. XII, fig. 3.

Munidopsis (Orophorhynchus) arietina ALCOCK, Cat. Indian Deep-Sea Crust. in the Indian Museum, p. 269.

Bay of Bengal in 1,520 fathoms.

MUNIDOPSIS ARMATA (A. Milne-Edwards).

Elasmonotus armatus A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 61.—HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 159, pl. XIX, fig. 5.—A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 282; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 104, pl. VIII, figs. 11-14.

Blake station 137, in 625 fathoms, West India region.

MUNIDOPSIS ASPERA (Henderson).

Elasmonotus asper HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 416; Challenger Report, XXVII, 1888, Anomura, p. 163, pl. XIX, fig. 4.

Munidopsis aspera FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 188; Mem. Mus. Comp. Zool., XVIII, 1895, p. 96.

Challenger station 311, off Patagonia, in 425 fathoms. Upward of a dozen specimens.

MUNIDOPSIS BAHAMENSIS, new species, see p. 278.

MUNIDOPSIS BAIRDII (Smith).

Galacantha bairdii SMITH, Report U. S. Fish Commission for 1882, 1884, p. 356.
Munidopsis bairdii SMITH, Proc. U. S. National Museum, VII, 1884, p. 493; Ann. Report U. S. Fish Commission for 1885, 1886, p. 649, pl. v, fig. 2.—FAXON, Mem. Mus. Comp. Zool., XVIII, 1895, p. 83.

Albatross station 2106, in 1,497 fathoms, off Virginia.

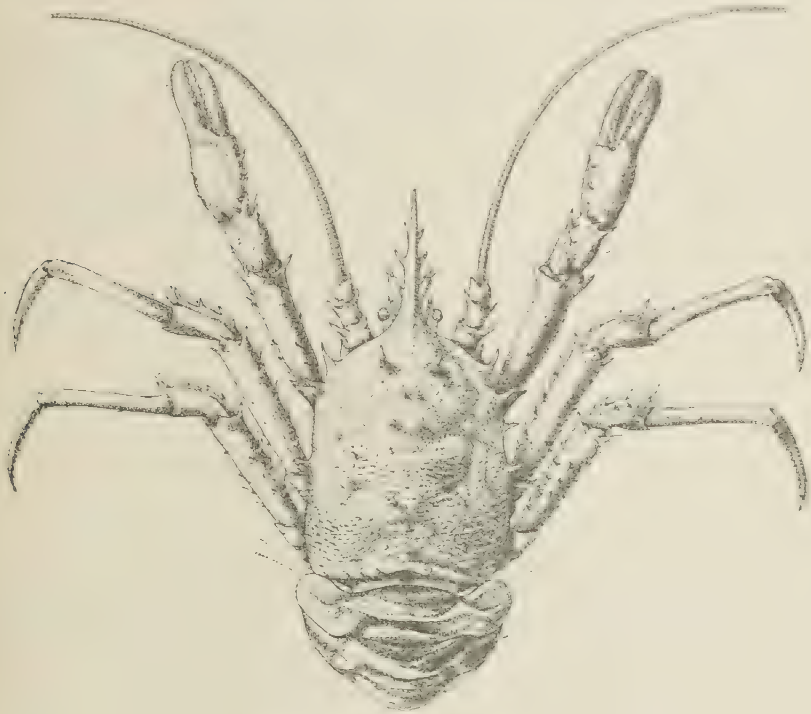

FIG. 47.—MUNIDOPSIS BAIRDII, × 1.

MUNIDOPSIS BERINGANA, new species, see p. 279.

MUNIDOPSIS CARINIPES Faxon.

Munidopsis carinipes FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 189; Mem. Mus. Comp. Zool., XVIII, 1895, p. 97, pl. xxiv, figs. 1, 1a, 1b.
Elasmonotus carinipes ALCOCK, Ann. and Mag. Nat. Hist., (6), 1894, XIII, p. 333.—A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., Zool., (7), XIV, 1893, p. 281.

Albatross station 3353, in 695 fathoms, off Panama.

MUNIDOPSIS CENTRINA Alcock and Anderson.

Munidopsis centrina ALCOCK and ANDERSON, Jour. Asiatic Soc. Bengal, LXIII, Pt. 2, 1894, p. 170; Illus. Zool. Investigator, Crust., 1895, pl. xi, fig. 6.
Munidopsis (*Orophorhynchus*) *centrina* ALCOCK, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 270.

Bay of Bengal, in 1,520 fathoms.

MUNIDOPSIS CERATOPHTHALMUS Alcock.

Munidopsis ceratophthalmus Alcock, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 271, pl. III, fig. 2.

Andaman Sea, in 480 fathoms.

MUNIDOPSIS CILIATA Wood-Mason.

Munidopsis ciliata Wood-Mason, Ann. Nat. Hist., 1891, p. 200.—Faxon, Mem. Mus. Comp. Zool., XVIII, 1895, p. 84, pl. XVIII, fig. 13.

Munidopsis brevimana Henderson, Ann. Mag. Nat. Hist., (5), 1885, XVI, p. 414; Challenger Report, Anomura, XXVII, 1888, p. 154, pl. XVII, figs. 1 and 2.—Alcock, Illus. Zool. of the Investigator, Crust., 1895, pl. xi, fig. 3.

Munidopsis (*Orophorhynchus*) *ciliata* Alcock, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 267.

Dr. Faxon's specimens were from *Albatross* stations 3353, in 695 fathoms; 3363, in 978 fathoms; 3392, in 1,270 fathoms; 3393, in 1,020 fathoms. Five specimens at the four stations.

Professor Henderson's specimens were from *Challenger* stations 191 off the Arrou islands, in 800 fathoms, and 218 between Papua and the Admiralty islands, in 1,070 fathoms.

The Indian Museum specimen was taken in the Bay of Bengal, in 1,310 fathoms.

Professor Henderson's figures 1 and 2 in the *Challenger* report probably represent two distinct species; not only the much smoother carapace and lack of prominent lateral spines in the young form shown in fig. 2, but the remarkable difference in the line of the front from the antero-lateral angle to the end of the rostrum, if the figures are correct, marks a difference not due to age. This is all the more likely, as the form shown in fig. 2 was taken at a distance from the form shown in fig. 1.

Munidopsis nitida A. Milne-Edwards, from the West India region, as has been pointed out by Dr. Faxon, is a closely related species; six specimens in this museum from station 2140 off Jamaica show a great range in size; five are under 6 mm. in length, and one is 21 mm., measured from the tip of the rostrum to the posterior margin of the carapace; in all, the lines of the front are much like *M. ciliata*, as shown in Professor Henderson's fig. 1, while the carapace is much more like fig. 2.

MUNIDOPSIS CRASSA S. I. Smith.

Munidopsis crassa S. I. Smith, Proc. U. S. Nat. Mus., VII, 1885, p. 494.—A Milne-Edwards and E. L. Bouvier, Ann. des Sci. Nat., 1894, (7), XVI, p. 275.

Off the east coast of the United States. *Albatross* station 2224, in 2,574 fathoms, latitude 36°.

MUNIDOPSIS CRINITA Faxon.

Munidopsis crinita FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 185; Mem. Mus. Comp. Zool., XVIII, 1895, p. 92, pl. XX, figs. 3, 3a.

Galathodes crinitus A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 279.

Albatross station 3384, in 458 fathoms, off Panama. One female.

MUNIDOPSIS CURVIROSTRA Whiteaves.

Munidopsis curvirostra WHITEAVES, Amer. Jour. Sci. and Arts, (3), VII, 1874, p. 212.—S. I. SMITH, Bull. Mus. Comp. Zool., X, 1882, p. 21, pl. VIII, figs. 2 and 3.

Off east coast of North America.

MUNIDOPSIS CYLINDROPHTHALMA (Alcock).

Elasmonotus cylindrophthalmus ALCOCK, Ann. Mag. Nat. Hist., (6), XIII, 1894, p. 333; Illus. Zool. Investigator, Crust., 1895, pl. XIII, fig. 4.

Munidopsis (*Elasmonotus*) *cylindrophthalmus* ALCOCK, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 272.

Andaman Sea, 188–220, 250, and 265 fathoms; Arabian Sea, 406 fathoms.

MUNIDOPSIS CYLINDROPUS, new species, see p. 281.

MUNIDOPSIS DASYPUS Alcock.

Munidopsis dasypus ALCOCK, Ann. and Mag. Nat. Hist., (6), XIII, 1894, p. 329; Illus. Investigator Crust., 1895, pl. XIII, fig. 9; Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 252.

Bay of Bengal, off the Andamans, 480 and 561 fathoms; Andaman Sea, 498 fathoms; Arabian Sea, 636 fathoms.

MUNIDOPSIS DEBILIS (Henderson).

Galathopsis debilis HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 417, 1885.

Elasmonotus debilis HENDERSON, Challenger Report, XXVII, Anomura, 1888, p. 165, pl. XVIII, fig. 4.

Challenger station 173, depth 315 fathoms. A male specimen. Station 210, among the Philippines, depth 375 fathoms. A male specimen.

MUNIDOPSIS DEPRESSA Faxon.

Munidopsis depressa FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 189; Mem. Mus. Comp. Zool., XVIII, 1895, p. 96, pl. XXII, figs. 2–2b.

Albatross station 3425, in 680 fathoms, off Mexico. One male.

MUNIDOPSIS EDWARDSII (Wood-Mason).

Elasmonotus edwardsii Wood-Mason, Ann. Mag. Nat. Hist., 1891, p. 201.
Orophorhynchus edwardsii Milne-Edwards and Bouvier, Ann. Sci. Nat., Zool., 1894, (7), XVI, p. 287.
Munidopsis (Orophorhynchus) edwardsii Alcock, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 265, pl. iii, fig. 4.

Bay of Bengal, in 1,300 and 1,310 fathoms.

MUNIDOPSIS ERINACEA (A. Milne-Edwards).

Galathodes erinacea A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 53.
Munidopsis erinacea Henderson, Challenger Report, XXVII, 1888, Anomura, p. 149, pl. xvi, fig. 4.—A. Milne-Edwards and Bouvier, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 67, pl. vii, figs. 9–12.

Milne-Edwards's specimens were from a number of stations in the West India region in depths that range a little above 400 fathoms (steamer *Blake*).

MUNIDOPSIS ESPINIS, new species, see p. 282.

MUNIDOPSIS EXPANSA, new species, see p. 282.

MUNIDOPSIS GILLI, new species, see p. 283.

MUNIDOPSIS GOODRIDGII Alcock and Anderson.

Munidopsis goodridgii Alcock and Anderson, Ann. Mag. Nat. Hist., (7), III, 1899, p. 21; Illus. Investigator Zoology, Crustacea, 1899, pl. xliv, fig. 2; Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 258.

A single female from off the Travancore coast, 430 fathoms.

MUNIDOPSIS GRANOSA Alcock.

Munidopsis granosa Alcock, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 266, pl. iii, fig. 1.

Bay of Bengal, in 1,520 fathoms.

MUNIDOPSIS HAMATA Faxon.

Munidopsis hamata Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, p. 187; Mem. Mus. Comp. Zool., XVIII, 1895, p. 95, pl. xxi, figs. 2–2b.

Albatross stations 3394 and 3395, in 411 and 730 fathoms, Gulf of Panama.

MUNIDOPSIS HASTIFER, new species, see p. 284.

MUNIDOPSIS HEMINGI Alcock and Anderson.

Munidopsis hemingi Alcock and Anderson, Ann. and Mag. of Nat. Hist., (7), III, 1901, p. 19; Illus. Zool. of the Investigator, Crust., pl. liv, fig. 4.—Alcock, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 251.

Off the Travancore coast, in 430 fathoms.

MUNIDOPSIS HENDERSONIANA Faxon.

Munidopsis hendersoniana FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 190; Mem. Mus. Comp. Zool., XVIII, 1895, p. 100, pl. XXIV, figs. 2–2e.

Orophorhynchus hendersoniana EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 287.

Albatross station 3393, in 1020 fathoms, Gulf of Panama.

MUNIDOPSIS HYSTRIX Faxon.

Munidopsis hystrix FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 183; Mem. Mus. Comp. Zool., XVIII, 1895, p. 89, pl. XIX, figs. 1, 1a.

Albatross station 3417, in 493 fathoms. Off Acapulco. Stations 3424 and 3425 in 676 and 680 fathoms, respectively, off Tres Marias Islands.

MUNIDOPSIS INERMIS Faxon.

Munidopsis inermis FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 191; Mem. Mus. Com. Zool., XVIII, 1895, p. 98, pl. XXIII, figs. 2, 2a.

Albatross station 3354 in 322 fathoms, Gulf of Panama.

MUNIDOPSIS IRIDIS Alcock and Anderson.

Munidopsis iridis ALCOCK and ANDERSON, Ann. Mag. Nat. Hist., (7), III, 1899, p. 20; Illus. Investigator Zool., Crust., 1899, pl. XLIV, fig. 1.—ALCOCK, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 255.

Fifty-two specimens from off the Travancore coast, 430 fathoms.

MUNIDOPSIS LÆVIGATA (Henderson).

Galathopsis lævigatus HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 417.

Elasmonotus lævigatus Challenger Report, XXVII, Anomura, p. 164, pl. XVIII, fig. 3.

Challenger station 219, depth 150 fathoms, North of Papua. One specimen.

MUNIDOPSIS LATIFRONS (A. Milne-Edwards).

Galathodes latifrons A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 57.—A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 279; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 94, pl. VIII, figs. 2, 3.

Blake station 288, in 399 fathoms, Barbados. One specimen.

MUNIDOPSIS LATIROSTRIS Faxon.

Elasmonotus latifrons HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 416; Challenger Report, XXVII, 1888, Anomura, p. 160, pl. XIX, fig. 1.

Orophorhynchus latifrons A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat. Zool., (7), XVI, 1894, p. 287.

Munidopsis latirostris FAXON, Mem. Mus. Comp. Zool., XVIII, 1895, p. 99.

Albatross station 3381, in 1,772 fathom , off Malpelo Island. One female. Station 3391, in 153 fathoms, Gulf of Panama. One female.

MUNIDOPSIS LEVIS (Alcock and Anderson).

Bathyankyristes levis Alcock and Anderson, Jour. Asiatic Soc. Bengal, LXIII, 1894, Pt. 2, p. 175; Illus. Zool. of the Investigator, Crustacea, pl. lv, fig. 3.
Munidopsis (*Bathyankyristes*) *levis* Alcock, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 274.

Arabian Sea, in the neighborhood of the Laccadives, 636 fathoms.

MUNIDOPSIS LIVIDA (A. Milne-Edwards).

Elasmonotus lividus A. Milne-Edwards, in Ed. Perrier, Les Explor. sous-marines, 1886, fig. 242.
Orophorynchus lividus A. Milne-Edwards and E. L. Bouvier, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 287, and fig. 12, p. 208; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 343, pl. iv, fig. 3; pl. xxxi, figs. 17–22.

MUNIDOPSIS LONGIMANA (A. Milne-Edwards).

Elasmonotus longimanus A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 60.—A. Milne-Edwards and E. L. Bouvier, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 282; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 106, pl. ix, figs. 1–6.

Blake station 195, in 502 fathoms, Martinique; station 130, in 451 fathoms, Frederickstad; station 221, 423 fathoms, St. Lucia; station 188, in 372 fathoms, Dominica; station 222, in 422 fathoms, St. Lucia.

MUNIDOPSIS LONGIROSTRIS Edwards and Bouvier.

Munidopsis longirostris A. Milne-Edwards and E. L. Bouvier, Bull. Mus. Nat. Hist., 1897, p. 365; Résult. des Camp. Scient. de l'Hirondelle et de la Princesse-Alice, Pt. 12, 1899, p. 82; Expéd. Scient. du Travailleur et du Talisman, Crust. Deca., Brachyures et Anomoures, 1900, p. 314, pl. iv, fig. 4; pl. xxx, figs. 5 to 9.

MUNIDOPSIS MARGARITA Faxon.

Munidopsis margarita Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, p. 184; Mem. Mus. Comp. Zool., XVIII, 1895, p. 91, pl. xx, fig. 2.

Albatross station 3404, in 385 fathoms. Male and female. Near the Galapagos Islands.

MUNIDOPSIS MARGINATA (Henderson).

Elasmonotus marginatus Henderson, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 416; Voyage of the Challenger, XXVII, 1888, Anomura, p. 161, pl. xix, fig. 2.
Orophorhynchus marginatus A. Milne-Edwards and E. L. Bouvier, Ann. des Sci. Nat., Zool., (7), XVI, 1894, pp. 286, 287.

Challenger station 168, off New Zealand; depth, 1,100 fathoms; bottom, blue mud.

MUNIDOPSIS MARIONIS (A. Milne-Edwards).

Galathodes marionis A. MILNE-EDWARDS, Rapport sur la faune sous-marine, p. 17 (note).

Orophorhynchus marionis A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des. Sci. Nat., Zool., (7), XVI, 1894, p. 287; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 340, pl. XXXI, figs. 14–16.

European waters.

MUNIDOPSIS MEDIA Edwards and Bouvier.

Munidopsis media A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, pp. 275, 325; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 325, pl. XXX, fig. 25.

European waters.

MUNIDOPSIS MIERSI (Henderson).

Elasmonotus miersi HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 416; Voyage of the Challenger, XXVII, 1888, Anomura, p. 162, pl. XIX, fig. 3.

Challenger station 173, off Matuku Island, Fiji; depth, 315 fathoms; bottom, coral mud.

MUNIDOPSIS MILLERI Henderson.

Munidopsis milleri HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 414; Challenger Report, XXVII, 1888, Anomura, p. 155, pl. XVII, fig. 3.

Challenger station 207, depth, 700 fathoms, off Tablas Island, Philippines. A female with ova and two males.

MUNIDOPSIS MINA, new species, see p. 285.

MUNIDOPSIS MODESTA, new species, see p. 286.

MUNIDOPSIS MORESBYI Alcock and Anderson.

Munidopsis moresbyi ALCOCK and ANDERSON, Ann. and Mag. Nat. Hist., (7), III, 1899, p. 22; Illus. of the Investigator, Zoology, Crust., 1899, pl. XL, fig. 3.—ALCOCK, Cat. Indian Deep-Sea Crustacea, 1901, p. 259.

Arabian Sea, off the Travancore coast, 430 fathoms.

MUNIDOPSIS NITIDA (A. Milne-Edwards).

Orophorhynchus nitidus A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 59.

Orophorhynchus spinosus A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 58.

Munidopsis nitida A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 74, pl. VI, figs. 6, 7.

Blake station 163, in 769 fathoms, Guadeloupe. Station 180, in 982 fathoms, Dominica.

MUNIDOPSIS OPALESCENS, new species, see p. 287.

MUNIDOPSIS ORNATA Faxon.

Munidopsis ornata FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 186; Mem. Mus. Comp. Zool., XVIII, 1895, p. 87, pl. XX, figs. 1, 1a.

Albatross station 3404, in 385 fathoms, Galapagos Islands.

MUNIDOPSIS PALLIDA Alcock.

Munidopsis subsquamosa var. pallida ALCOCK, Ann. Mag. Nat. Hist., (6), XIII, 1894, p. 331; Illus. Zool. Investigator, Crustacea, 1895, pl. XIII, fig. 7.

Munidopsis (Orophorhynchus) subsquamosa var. pallida ALCOCK, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 268.

Bay of Bengal in 1,803 fathoms.

MUNIDOPSIS PARFAITI (A. Milne-Edwards).

Elasmonotus parfaiti A. MILNE-EDWARDS, in Filhol, La Vie au Fond des Mers, 1885, pl. VII.

Orophorhynchus parfaiti A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI., 1894, p. 287; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 236, pl. III, fig. 1; pl. XXXI, fig. 11–13.

European waters.

MUNIDOPSIS PILOSA Henderson.

Munidopsis pilosa HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 415; Challenger Report, XXVII, Anomura, 1888, p. 157, pl. XVII, fig. 5.

Challenger station 196; depth 825 fathoms, near Philippine Islands. One male.

MUNIDOPSIS PLATIROSTRIS (A. Milne-Edwards and Bouvier.)

Orophorhynchus platirostris A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 287; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 114, pl. IX, figs. 12–15; pl. X, fig. 3.

U. S. Coast Survey steamer *Hassler*, December 27–30, 1871, 100 fathoms, Barbados.

MUNIDOPSIS POLITA (S. I. Smith).

Anoplonotus politus S. I. SMITH, Proc. U. S. Nat. Mus., VI, 1883, p. 50, pl. II, fig. 1; pl. III, figs. 1–5a.

East North Atlantic.

Dr. Faxon says:[a] "As the genus *Anoplonotus* of Smith does not seem to be sufficiently distinct from *Elasmonotus*, it is here merged, with the latter, in *Munidopsis*."

[a] Mem. Mus. Comp. Zool., XVIII, 1895, p. 81.

MUNIDOPSIS POSEIDONIA Alcock and Anderson.

Munidopsis poseidonia ALCOCK and ANDERSON, Jour. Asiatic Soc. Bengal, LXIII, Pt. 2, 1894, p. 167; Illus. Zool. Investigator, Crust., pl. XII, fig. 2.

Munidopsis (Galathodes) posidonia ALCOCK, Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 263.

Bay of Bengal, off Madras coast, 210 fathoms.

MUNIDOPSIS QUADRATA Faxon.

Munidopsis quadrata FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 188; Mem. Mus. Comp. Zool., 1895, p. 97, pl. XXIII, figs. 1, 1c.

Elasmonotus quadratus A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 282.

Albatross station 3424, in 676 fathoms, and station 3425 in 680 fathoms, Tres Marias Islands.

MUNIDOPSIS REGIA Alcock and Anderson.

Munidopsis regia ALCOCK and ANDERSON, Jour. Asiatic Soc. Bengal, LXIII, Pt. 2, 1894, p. 168; Illus. Zool. Investigator, Crust., 1895, pl. XI, fig. 1; Cat. Indian Deep-Sea Crust. in the Indian Museum, 1901, p. 261.

Arabian Sea, off Colombo, 142–400 fathoms, Andaman Sea, 405 fathoms.

MUNIDOPSIS REYNOLDSI (A. Milne-Edwards).

Galathodes reynoldsi A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 56.

Munidopsis reynoldsi A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 80, pl. VI, figs. 1–5.

Blake station 138 in 2,376 fathoms, Ham's Bluff.

MUNIDOPSIS ROBUSTA (A. Milne-Edwards).

Galathodes robustus A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 54.

Munidopsis robusta A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 69, pl. VI, figs. 15–20; pl. VII, fig. 1.

Blake station 258 in 159 fathoms, Grenada.

MUNIDOPSIS SCABRA Faxon.

Munidopsis scabra FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 186; Mem. Mus. Comp. Zool., XVIII, 1895, p. 93, pl. XXI, figs. 1, 1a.

Albatross station 3424 in 676 fathoms, and station 3425 in 680 fathoms, Tres Marias Islands.

MUNIDOPSIS SCOBINA Alcock.

Munidopsis scobina ALCOCK, Ann. Mag. Nat. Hist., (6), XIII, 1894, p. 330; Illus. Investigator, Crust., 1895, pl. XIII, fig. 1; Cat. Indian Deep-Sea Crust. Indian Museum, 1901, p. 254.

Northern end of the Bay of Bengal, 193, 240, 272, 405–285, and 409 fathoms.

MUNIDOPSIS SERICEA Faxon.

Munidopsis sericea FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 184; Mem. Mus. Comp. Zool., XVIII, 1895, p. 90, pl. XIX, figs. 3, 3a.

Albatross station 3394 in 511 fathoms, Gulf of Panama.

MUNIDOPSIS SERRATIFRONS (A. Milne-Edwards).

Galathodes serratifrons A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, No. 1, 1880, p. 55.

Munidopsis serratifrons HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 149, pl. XVI, fig. 3.— A. MILNE-EDWARDS and E. L. BOUVIER, Mem. Mus. Comp. Zool., XIX, 1897, p. 78, pl. VI, fig. 12–14.

Blake station 185 in 333 fathoms, Dominica; *Challenger* station 56, off Bermuda, in 1,075 fathoms; *Albatross* station 2154, in 310 fathoms, off Habana, Cuba.

MUNIDOPSIS SHARRERI (A. Milne-Edwards).

Orophorhynchus sharreri A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 59.

Munidopsis sharreri A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 71, pl. VII, fig. 2–5.

Santa Cruz, in 248 fathoms, steamer *Blake*.

MUNIDOPSIS SIGSBEI (A. Milne-Edwards).

Galathodes sigsbei A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 56.

Munidopsis sigsbei HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 150, pl. XVIII, fig. 2.—A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 83, pl. V, fig. 8–26.

Blake station 200 in 472 fathoms, Martinique.

MUNIDOPSIS SIMILIS S. I. Smith.

Munidopsis similis S. I. SMITH, Proc. U. S. Nat. Mus., VII, 1885, p. 496.—A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 275.

Off the east coast of the United States: *Albatross* station 2192, latitude 39°, in 1,060 fathoms.

MUNIDOPSIS SIMPLEX (A. Milne-Edwards).

Galathodes simplex A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 56.

Munidopsis simplex A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2. p. 89, pl. V, figs. 2–7.

Guadeloupe, Martinique, St. Vincent, 333 to 982 fathoms.

MUNIDOPSIS SPINIFER A. Milne-Edwards.

Munidopsis spinifer A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 54.—A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat. Zool., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 64, pl. VII, figs., 6–8.

Blake, station 146, in 245 fathoms; St. Kitts. Station 100 in 250 to 400 fathoms.

MUNIDOPSIS SPINOCULATA (A. Milne-Edwards).

Orophorhynchus spinoculatus A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 59.

Munidopsis spinoculata A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 275; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 75, pl. VI, figs. 8–11.

Dominica, in 824 fathoms.

MUNIDOPSIS SQUAMOSA (A. Milne-Edwards).

Orophorhynchus squamosus A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 58.

Elasmonotus squamosus A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 282; Mem. Mus. Comp. Zool, XIX, 1897, No. 2, p. 99, pl. VIII, figs. 4–6.

St. Lucia, in 116 fathoms.

MUNIDOPSIS STYLIROSTRIS Wood-Mason.

Munidopsis stylirostris WOOD-MASON, Ann. Mag. Nat. Hist., (6), 1891, p. 201.—ALCOCK, Ann. Mag. Nat. Hist., (6), XIII, 1894, p. 328; Illus. Investigator, Zool., Crust., 1895, pl. XIII, fig. 6.

Arabian Sea, in 738, 824, 836, and 947 fathoms.

MUNIDOPSIS SUBSQUAMOSA Henderson.

Munidopsis subsquamosa HENDERSON, Ann. and Mag. Nat. Hist., (5), XVI, 1885, p. 414; Challenger Report, XXVII, Anomura, 1888, p. 152, pl. XVII, fig. 4.—ALCOCK, Cat. Indian Deep-Sea Crust. in Indian Museum, 1901, p. 256; Mem. Mus. Comp. Zool., XVIII, 1895, p. 85.

Challenger, station 237, in 1875 fathoms, off Yokohama.

MUNIDOPSIS TALISMANI Edwards and Bouvier.

Munidopsis talismani A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 275; Expéd. Scient. du Travailleur et du Talisman, Brachyures and Anomoures, 1894, p. 316, pl. XXX, figs. 11–14.

European waters.

MUNIDOPSIS TANNERI Faxon.

Munidopsis tanneri FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 187; Mem. Mus. Comp. Zool., XVIII, 1895, p. 94, pl. XXII, figs. 1, 1a.

Albatross station 3396, in 259 fathoms, gulf of Panama; station 3397, in 85 fathoms, Gulf of Panama.

MUNIDOPSIS TAURULUS Ortmann.

Munidopsis taurulus Ortmann, Zool. Jahrb., System, 1892, p. 256, pl. II, fig. 13.

MUNIDOPSIS TENAX Alcock.

Bathyankyristes spinosus Alcock, Jour. Asiatic Soc. Bengal, LXIII, 1894, Pt. 2, p. 174, pl. IX, fig. 2; Illus. Zool. Investigator, Crustacea, pl. LV, fig. 2.

Munidopsis (*Bathyankyristes*) *tenax* Alcock, Cat. Indian Deep-Sea Crust. Indian Museum, 1901, p. 273.

Andaman Sea, off Ross Island, 265 fathoms.

MUNIDOPSIS TENUIROSTRIS, new species, see p. 289.

MUNIDOPSIS TOWNSENDI, new species, see p. 290.

MUNIDOPSIS TRACHYPUS Alcock and Anderson.

Munidopsis trachypus Alcock and Anderson, Jour. Asiatic Soc. Bengal, LXIII, 1894, Pt. 2, p. 169; Illus. Zool. Investigator, Crust., 1895, pl. XI, fig. 2.—Alcock, Cat. Indian Deep-Sea Crust. Indian Museum, 1901, p. 262.

Arabian Sea, north of the Laccadives, 636 fathoms.

MUNIDOPSIS TRIÆNA Alcock and Anderson.

Munidopsis triæna Alcock and Anderson, Jour. Asiatic Soc. Bengal, LXIII, 1894, Pt. 2, p. 168; Illus. Investigator Zool. Crust., 1895, pl. XI, fig. 5.

Munidopsis (*Galathodes*) *triæna* Alcock, Cat. Indian Deep-Sea Crust. Indian Museum, 1901, p. 261.

Bay of Bengal, off the Andaman coast, in 240–290 and 375 fathoms.

MUNIDOPSIS TRIDENS (A. Milne-Edwards).

Galathodes tridens A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 57.—A. Milne-Edwards and Bouvier, Ann. des Sci. Nat., (7), XVI, 1894, p. 279; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 96, pl. VII, figs. 13–15; pl. VIII, fig. 1.

Blake station 148, in 208 fathoms, St. Kitts.

MUNIDOPSIS TRIDENTATA (Esmark).

Galathea tridentata Esmark, Forhdl. Skandin. Naturf., 7 Möde, (1856), 1857, p. 157.

Galathodes rosaceus A. Milne-Edwards, Rec. de Fig. de Crust., 1883, pl. XIII, fig. 1.

Galathodes tridentatus A. Milne-Edwards and E. L. Bouvier, Crust. Hirondelle et Princesse-Alice, Monaco, 1899, p. 83.

? *Munidopsis rosacea* Alcock and Anderson, Ann. Mag. Nat. Hist., 1899, (7), III, p. 19.

Munidopsis (*Galathodes*) ? *tridentata* Alcock, Cat. Indian Deep-Sea Crust., Indian Museum, 1901, p. 264.

"Two hundred and thirty-seven specimens were taken in the Arabian Sea, off the Travancore coast, in 430 fathoms."

MUNIDOPSIS TRIFIDA Henderson.

Munidopsis trifida HENDERSON, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 415: Challenger Report, XXVII, 1888, Anomura, p. 156, pl. XVI, fig. 2.
Galathodes trifidus A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 279.

Challenger station 310, in 400 fathoms, Sarmiento Channel, Patagonia.

Mr. Henderson describes his specimens as having "a few short hairs scattered over the surface." This is true of the specimens in this museum, one from *Albatross* station 2781, in 348 fathoms, and one from station 2785 in 449 fathoms. Both stations are off the west coast of Patagonia at no great distance from the type locality of *M. trifida*.

Alcock and Anderson[a] have referred to *M. trifida* specimens from the "Arabian Sea, north of the Laccadives, 636 fathoms; Bay of Bengal, off the Andamans, 480 fathoms; Andaman Sea, 498 fathoms." Contrary to the character of the type and topotypes, these specimens are described as tomentose. "Body and appendages tomentose. Carapace when denuded transversely rugose, especially postero-laterally."

It does not seem at all improbable that specimens from localities so widely separated and differing so much in the amount of hair (the one being naked and the other clothed) would show additional diverse characters when placed side by side; however, in the absence of intergrading specimens, this character alone renders the forms specifically distinct. I therefore propose that the form from the Indian Seas be known as *Munidopsis tomentosa*.

MUNIDOPSIS UNGUIFERA Alcock and Anderson.

Munidopsis unguifera ALCOCK and ANDERSON, Jour. Asiatic Soc. Bengal, LXIII, Pt. 2, 1894, p. 172; Illus. Investigator Zool., Crust., 1895, pl. XI, fig. 4.—ALCOCK, Cat. Indian Deep-Sea Crust., 1901, p. 253.

Bay of Bengal, in 145–250 fathoms. Andaman Sea, in 490 fathoms.

MUNIDOPSIS VAILLANTI (A. Milne-Edwards).

Elasmonotus vaillanti A. MILNE-EDWARDS, Comp. Rend. Acad. des Sci., p. 932, Dec., 1881.—A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 282; Expéd. Scient. du Travailleur et du Talisman, Brachyures et Anomoures, 1900, p. 333, pl. XXXI, fig. 8–10.

MUNIDOPSIS VERRILLI, new species, see p. 291.

MUNIDOPSIS VICINA Faxon.

Munidopsis vicina FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 181; Mem. Mus. Comp. Zool., XVIII, 1895, p. 85, pl. XVIII, figs. 2–2a.

Albatross station 3360, in 1,670 fathoms, Gulf of Panama; station 3382 in 1,793 fathoms, Gulf of Panama.

[a] Jour. Asiatic Soc. Bengal, LXIII, Pt. 2, 1894, p. 168.

MUNIDOPSIS VILLOSA Faxon.

Munidopsis villosa Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, p. 182; Mem. Mus. Comp. Zool., XVIII, 1895, p. 86, pl. XIX, fig 2.

Albatross station 3394, in 511 fathoms, Gulf of Panama.

MUNIDOPSIS WARDENI Anderson.

Munidopsis wardeni Anderson, Jour. Asiatic Soc. Bengal, LXV, Pt. 2, 1896, p. 99; Illus. Investigator Zool., Crust., pl. LV, fig. 1.—Alcock, Cat. Indian Deep-Sea Crust, 1901, p. 257.

Arabian Sea, in 406, 457–589, 459, and 531 fathoms; Bay of Bengal, in 480 and 594–225 fathoms.

UROPTYCHUS Henderson.

Diptychus A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 61 (name preoccupied).

Uroptychus (new name) Henderson, Report Voyage Challenger, 1888, p. 173.

UROPTYCHUS ARMATUS (A. Milne-Edwards).

Diptychus armatus A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 59.—A. Milne-Edwards and E. L. Bouvier, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 306.—Mem. Mus. Comp. Zool., XIX, No. 2, p. 132, pl. XI, fig. 3; pl. XII, figs. 8 and 9.

Blake station 241; depth, 163 fathoms; Cariacou.

UROPTYCHUS AUSTRALIS (Henderson).

Diptychus australis Henderson, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 420.

Uroptychus australis Henderson, Challenger Report, XXVII, 1888, Anomura, p. 179, pl. XXI, fig. 4.

Challenger station 171, near the Kermadec Islands; depth, 600 fathoms.

UROPTYCHUS AUSTRALIS var. INDICUS Alcock.

Uroptychus australis var. indicus Alcock, Cat. Indian Deep-Sea Crust. Indian Museum, 1901, p. 284.

Arabian Sea, off Cape Comorin, 459 fathoms; Bay of Bengal, off Ceylon, 805 fathoms.

UROPTYCHUS BACILLIMANUS Alcock and Anderson.

Uroptychus bacillimanus Alcock and Anderson, Ann. Mag. Nat. Hist., (7), III, 1899, p. 25; Illus. Zool. Investigator, Crust., 1899, pl. XLV, fig. 3.—Alcock, Cat. Indian Deep-Sea Crust. in Indian Museum, 1901, p. 285.

A young male and female from off the Travancore coast, 430 fathoms, and an egg-laden female from off Ceylon, 320–296 fathoms.

UROPTYCHUS BELLUS Faxon.

Uroptychus bellus FAXON, Bull. Mus. Comp. Zool., XXIV, 1893, p. 193; Mem. Mus. Comp. Zool., 1895, p. 102, pl. XXVI, figs. 2–2b.
Diptychus bellus A. MILNE-EDWARDS and BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 306.

Albatross station 3354, in 322 fathoms. Station 3355, 182 fathoms, off Panama.

UROPTYCHUS BREVIS, new species, see p. 292.

UROPTYCHUS CAPILLATUS, new species, see p. 293.

UROPTYCHUS FUSIMANUS Alcock and Anderson.

Uroptychus fusimanus ALCOCK and ANDERSON, Ann. Mag. Nat. Hist., (7), III, 1899, p. 26; Illus. Zool. Investigator, Crust., 1899, pl. XLIV, fig. 4.—ALCOCK, Cat. Indian Deep-Sea Crust. Indian Museum, 1901, p. 283.

Seven specimens from off the Travancore coast, in 430 fathoms.

UROPTYCHUS GRACILIMANUS (Henderson).

Diptychus gracilimanus HENDERSON, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 420.
Uroptychus gracilimanus HENDERSON, Challenger Report, XXVII, 1888, Anomura, p. 181, pl. XXI, fig. 5.

Challenger station 164B, off Port Jackson; depth, 410 fathoms.

UROPTYCHUS GRANULATUS, new species, see p. 293.

UROPTYCHUS INSIGNIS (Henderson).

Diptychus insignis HENDERSON, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 419.
Uroptychus insignis HENDERSON, Challenger Report, Anomura, XXVII, 1888, p. 175, pl. XXI, fig. 1.

Challenger station 145A, off Prince Edwards Island; depth, 310 fathoms.

UROPTYCHUS INTERMEDIUS (A. Milne-Edwards).

Diptychus intermedius A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 63; Mem. Mus. Comp. Zool., XIX, No. 2, 1897, p. 127, pl. XII, fig. 1–7.

Blake station 241; depth, 163 fathoms; Cariacou.

UROPTYCHUS JAMAICENSIS, new species, see p. 29

UROPTYCHUS MINUTUS, new species, see p. 296.

UROPTYCHUS NIGRICAPILLIS Alcock.

Uroptychus nigricapillis ALCOCK, Cat. Indian Deep-Sea Crust. Indian Museum, 1901, p. 283, pl. III, fig. 3.

Andaman Sea, 669 fathoms.

UROPTYCHUS NITIDUS (A. Milne-Edwards).

Diptychus nitidus A. Milne-Edwards, Bull. Mus. Comp. Zool., VIII, 1880, p. 62.—A. Milne-Edwards and Bouvier, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 306; Mem. Mus. Comp. Zool., XIX, 1897, p. 134, pl. xi, figs. 21, 22; pl. xii, figs. 10–16.

Uroptychus nitidus Henderson, Challenger Report, Anomura, XXVII, 1888, p. 174, pl. xxi, fig. 6.

Blake station 137; depth, 625 fathoms; Frederickstadt. Station 227; depth, 273 fathoms.

UROPTYCHUS NITIDUS var. CONCOLOR (Edwards & Bouvier).

Diptychus nitidus var. concolor A. Milne-Edwards and Bouvier, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 306; Résult. des camp. scient. de l'Hirondelle (supplément) et de la Princesse-Alice, Pt. XIII, p. 87, pl. i, fig. 2.—Edwards and Bouvier, Expéd. Sci. du Travailleur et du Talisman, 1900, p. 360, pl. iv, pl. xxxii, fig. 15–19.

Uroptychus nitidus var. concolor M. Caulliery, Result. de la camp. du Caudan, II, p. 393.

UROPTYCHUS OCCIDENTALIS Faxon.

Uroptychus nitidus occidentalis Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, p. 192; Mem. Mus. Comp. Zool., XVIII, 1895, p. 101, pl. xxvi, figs. 1, 1a.

Diptychus nitidus var. occidentalis Milne-Edwards and Bouvier, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 306.

Albatross, station 3384; depth, 458 fathoms; off Panama.

See *Uroptychus occidentalis*, Key, p. 292.

UROPTYCHUS PARVULUS (Henderson).

Diptychus parvulus Henderson, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 420.

Uroptychus parvulus Henderson, Challenger Report, XXVII, 1888, p. 177, pl. xxi, fig. 3.

Challenger station 310; Sarmiento Channel, Patagonia; depth, 400 fathoms.

UROPTYCHUS POLITUS (Henderson).

Diptychus politus Henderson, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 420.

Uroptychus politus Henderson, Challenger Report, Anomura, XXVII, 1888, p. 178, pl. vi, fig. 2.

Challenger station 171, near the Kermadec Islands; depth, 600 fathoms.

UROPTYCHUS PRINCEPS, new species, see p. 296.

UROPTYCHUS PUBESCENS Faxon.

Uroptychus pubescens Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, p. 192; Mem. Mus. Comp. Zool., XVIII, 1895, p. 101, pl. xxvi, figs. 3, a, b.

Diptychus pubescens A. Milne-Edwards and Bouvier, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 306.

Albatross stations 3354, in 322 fathoms, and 3355, in 182 fathoms, off Panama.

UROPTYCHUS RUBRO-VITTATUS (A. Milne-Edwards.)

Diptychus rubro-vittatus A. MILNE-EDWARDS, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 306; Expéd. Sci. du Travailleur et du Talisman, 1900, p. 356, pl. XXXII, fig. 6–14.—M. CAULLERY, Résult. de la camp. du Caudan, Pt. 2, 1896, p. 393.

UROPTYCHUS RUGOSUS (A. Milne-Edwards).

Diptychus rugosus A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 63.—A. MILNE-EDWARDS and E. L. BOUVIER, Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 124, pl. XI, figs. 4–14.

West India region, in 95 to 240 fathoms.

UROPTYCHUS SCAMBUS, new species, see p. 297.

UROPTYCHUS SCANDENS, new species, see p. 298.

UROPTYCHUS SPINIGER, new species, see p. 298.

UROPTYCHUS SPINIMARGINATUS (Henderson).

Diptychus spinimarginatus HENDERSON, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 419.

Uroptychus spinimarginatus HENDERSON, Challenger Report, Anomura, XXVII, 1888, p. 176, pl. XXI, fig. 2.

Challenger station 170, off Kermadec Islands; depth, 520 fathoms.

UROPTYCHUS SPINOSUS (A. Milne-Edwards and E. L. Bouvier).

Diptychus spinosus A. MILNE-EDWARDS and BOUVIER, Ann. des. Sci. Nat., Zool., (7), XVI, 1894, p. 306; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 129, pl. XI, figs. 15–20.

West India region.

UROPTYCHUS TRIDENTATUS (Henderson).

Diptychus tridentatus HENDERSON, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 421.

Uroptychus tridentatus HENDERSON, Challenger Report, XXVII, 1888, p. 181, pl. VI, fig. 1.

Amboina, depth?

UROPTYCHUS UNCIFER (A. Milne-Edwards).

Diptychus uncifer A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 63.—A. MILNE-EDWARDS and BOUVIER, Ann. Sci. Nat., Zool., (7), XVI, 1894, p. 306; Mem. Mus. Comp. Zool., XIX, 1897, No. 2, p. 140, pl. XI, figs. 1 and 2; pl. XII, figs. 17–29.

Blake station 232; depth, 88 fathoms; St. Vincent. Station 273; depth, 103 fathoms; Barbados. Station 269; depth, 124 fathoms; St. Vincent.

PTYCHOGASTER A. Milne-Edwards.

Ptychogaster A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 63.

PTYCHOGASTER DEFENSA, new species, see p. 299.

PTYCHOGASTER FORMOSUS A. Milne-Edwards.

Ptychogaster formosus A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 205, fig. 9; p. 216, fig. 20.—A. MILNE-EDWARDS and E. L. BOUVIER, Expd. Scient. du Travailleur et du Talisman, Crust. Decap. Brachyures et Anomoures, 1900, p. 350, pl. III, fig. 2; pl. XXXII, fig. 1–5. See for Synonymy.

PTYCHOGASTER HENDERSONI Alcock and Anderson.

Ptychogaster hendersoni ALCOCK and ANDERSON, Ann. Mag. Nat. Hist., Jan., 1899, p. 23.—ALCOCK, Cat. Indian deep-sea Crust. Indian Museum, 1901, p. 280; Illus. Zool. Investigator, Crust., pl. XLV, fig. 2.

PTYCHOGASTER INVESTIGATORIS Alcock and Anderson.

Ptychogaster investigatoris ALCOCK and ANDERSON, Ann. Mag. Nat. Hist., Jan., 1899, p. 24; Illus. Zool. Investigator, Crust., pl. XLV, fig. 1.—ALCOCK, Cat. Indian deep-sea Crust. Indian Museum, 1901, p. 281.

PTYCHOGASTER LÆVIS Henderson.

Ptychogaster lævis HENDERSON, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 418; Challenger Rept., XXVII, 1888, Anomura, p. 172, pl. XX, fig. 3.—A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 302.

PTYCHOGASTER MILNE-EDWARDSI Henderson.

Ptychogaster milne-edwardsi HENDERSON, Narr. Chall. Exp., I, 1885, p. 900, fig. 330; Ann. Mag. Nat. Hist., (5), 1885, XVI, p. 418; Rep. Anomura Challenger Ex., XXVII, 1888, p. 171, pl. XX, fig. 2.

PTYCHOGASTER SPINIFER A. Milne-Edwards.

Ptychogaster spinifer A. MILNE-EDWARDS, Bull. Mus. Comp. Zool., VIII, 1880, p. 64.—A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, p. 302; Mem. Mus. Comp. Zool., XIX, No. 2, 1897, p. 118; pl. IX, fig. 16–22; pl. X, fig. 4–16.

EUMUNIDA S. I. Smith.

EUMUNIDA PICTA S. I. Smith.

Eumunida picta S. I. SMITH, Proc. U. S. Nat. Mus., VI, 1883, p. 44, pl. II, fig. 2; pl. III, fig. 6–10; pl. IV, fig. 1–3; Report Com. Fish and Fisheries, p. 46 (1885), 1886.—A. MILNE-EDWARDS and E. L. BOUVIER, Ann. des Sci. Nat., Zool., (7), XVI, 1894, pp. 211, 230, fig. 14; Expéd. Sci. du Travailleur et du Talisman, Brachyures et Anomoures, p. 364, 1900, pl. V, fig. 1; pl. XXVIII, fig. 26; pl. XXXII, figs. 20–24.

EUMUNIDA SMITHII Henderson.

Eumunida smithii HENDERSON, Ann. Mag. Nat. Hist., (5), XVI, 1885, p. 413; Voyage of the Challenger, Report on the Anomura, XVII, 1888, p. 169, pl. XV, fig. 5.

SYNOPSIS OF THE FAMILY VENERIDÆ AND OF THE NORTH AMERICAN RECENT SPECIES.

By William Healey Dall,

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This synopsis is one of a series of similar summaries of the families of bivalve mollusks which have been prepared by the writer in the course of a revision of our Pelecypod fauna in the light of the material accumulated in the collections of the United States National Museum. While the lists of species are made as complete as possible, for the coasts of the United States, the list of those ascribed to the Antilles, Central and South America, is probably subject to considerable additions when the fauna of these regions is better known and the literature more thoroughly sifted. No claim of completeness is therefore made for this portion of the work, except when so expressly stated. So many of the southern forms extend to the verge of our territory that it was thought well to include those known to exist in the vicinity when it could be done without too greatly increasing the labor involved in the known North American list.

The publications of authors included in the bibliography which follows are referred to by date in the text, but it may be said that the full explanation of changes made and decisions as to nomenclature arrived at is included in the memoir on the Tertiary fauna of Florida in course of publication by the Wagner Institute, of Philadelphia, for the writer, forming the third volume of their transactions. The rules of nomenclature cited in Part III of that work (pp. 561–565) are those upon which this revision has been founded, and are believed to express the opinions of the majority of those who have given thorough study to the subject of nomenclature. Authors who do not accept the British Association rules, as thus developed, can not expect to find their personal views reflected in this revision.

It may be thought that the subdivision of groups has been carried farther than desirable, to which the writer can only reply that in tracing the genealogy of our recent species through the Tertiary,

from horizon to horizon, he has found the minor divisions of very great assistance, the more thorough scrutiny and study which they naturally require, and which is irksome to superficial students, being essential to really thorough work in paleontology, and no small help in handling the recent forms. On the other hand, those whose studies do not require this insistence on apparently minor characteristics do not need to use the sectional names, and may easily fall back on those names by which the larger groups are called.

The family Veneridæ represents the culmination of Pelecypod evolution, so far as this may be represented by any single family. In beauty of color and delicacy of color pattern, in multiplicity and variety of sculptural developments, in wide distribution and bathymetric range, the Veneridæ equal if they do not surpass any other Teleodont group. While the shells are often exquisitely beautiful, the coloration and appendages of the soft parts are also frequently similarly attractive, leading to wonder why parts which are always covered by the mud or sand or hidden between the valves should develop such beauties. The periostracum is usually thin and inconspicuous, but sometimes by color or quality of surface adds attractiveness to shells otherwise dull or colorless.

The geographical distribution of groups in the Veneridæ has some marked characteristics, which are especially brought out when the distribution is scrutinized by the minor groups, such as sections. Omitting fossils, which in the main agree very closely with the recent species in distribution, *Sunetta* and the whole group covered by *Gafrarium* and *Lioconcha*, except the section *Gouldia; Meretrix*, and most of the sections of *Cytherea*, except *Cytherea* and *Ventricola*, *Mysia*, *Gomphina*, *Macridiscus;* most of the sections of *Katalysia*, and all the great group of *Paphia*, except the usually dull and unattractive *Protothaca*, are unknown in the waters of the New World.

On the other hand, *Transennella*, *Pachydesma*, *Hysteroconcha*, *Cyclinella*, and *Parastarte* appear to be exclusively American. *Eurirela* and *Eucallista* belong to the southeastern shores of America, *Liocyma* to the boreal seas, *Saxidomus* and *Protothaca* to the west coast of America, with slight extensions to northeastern Asia and Australasia. *Venus* is originally and typically American, with one emigrant in northern Japan. *Gemma* and *Psephidia* agree in the main with *Venus*. No member of the group of *Circe* or *Gafrarium* occurs on the Pacific coast, though I anticipate that *Gouldia* will turn up there sooner or later. *Chionella*, *Pitaria*, *Katalysia*, and *Venerupis* are almost ubiquitous. Of the Dosiniinæ only *Clementia* and *Dosinidia* are known to be residents of America. In harmony with the late development and specialization of the family is the fact that of the one hundred and thirty-seven species known as American only two exist on both shores of North America. Eighteen species extend through

the temperate and boreal regions, belonging to twelve groups, of which *Saxidomus* and *Psephidia* have no representatives known in our tropical waters. The Tropics in America have representatives of twenty-nine groups, of which *Tivela* and *Chione* are the most prolific in species; none of the other groups exceeds four species. In individuals the groups of the Temperate Zone seem to be most prolific, such as *Venus*, *Protothaca*, *Saxidomus*, and *Agriopoma*, and from these the greater portion of the food supply derived from members of this family by man is obtained.

The southern limit of the tropical fauna on the west coast of South America is near Payta, Peru. On the east coast it descends at least as far as Rio de Janeiro, its northern limit reaching the latitude of Cape Hatteras offshore and Cape Canaveral on the actual coast. On the west coast the temperate fauna meets the northernmost extension of the tropical fauna near Point Conception, California. The northern limit of the strictly temperate-region fauna, on the west, is the line of floating ice in winter in Bering Sea, about the latitude of the Pribilof group of islands. On the east we may put the boundary near Cape Breton Island, but, owing to the inshore polar current on this side of the continent, the arctic species reach farther south and the census of the temperate fauna is more meager than on the more favored north-west coast of the continent or the western shores of Europe in the same latitude.

The recognizable ancestry of the Veneridæ appears in the Upper Cretaceous or Lower Eocene. No true Venerid, in the strict sense, appears before the Tertiary. The modifications followed through the successive horizons are most interesting. Thus, in the Oligocene we have *Hyphantosoma* with fine zigzag chiseling of the surface. In the Pliocene this sculpture is obsolete and its traces hardly to be found. The recent type has a smooth surface, but when attacked by decay the manner in which the shell weathers reveals the zigzag internal structure hidden under an apparently normal, smooth exterior, and the color-pattern frequently follows a zigzag lineation which is no longer expressed in terms of sculpture.

The beauty of the shells has led in some cases to a traffic in them by means of aboriginal trade. Thus *Hysteroconcha* was long carried to the Orient by the Lascar crews of ancient Spanish galleons, and this has led to wrong ideas of geographical distribution. *Meretrix* is a favorite with the Chinese and Japanese, not merely as a source of food or ornament, but is incorporated into lacquer work and imitated in porcelain or pottery. The common *Venus* of our own eastern coast was the source from which the Dutch and Indians prepared their shell money or wampum and ceremonial belts. A south European species in ancient times was the emblem of Aphrodite, and in the South Seas species of Veneridæ were largely used for personal adornment.

TABLE OF DISTRIBUTION OF NORTH AMERICAN VENERIDÆ.

W.=WEST COAST; E.=EAST COAST.

[Extralimital species in parentheses.]

Genus and section.	Temperate or Oregonian. W.	Temperate or Oregonian. E.	Tropical or Panamic. W.	Tropical or Panamic. E.
Dosinia:				
Dosinidia	....	....	3	3
Clementia	....	....	1	....
Transennella	1	....	1	3
Tivela	....	....	7	5
Pachydesma	....	....	1	(1)
Gafrarium:				
Gouldia	....	....	....	3
Macrocallista	....	....	....	1
Chionella	....	....	4	1
Amiantis	....	....	1	....
Eucallista	....	....	....	1
Callocardia	....	....	....	1
Agriopoma	....	1	1	3
Pitaria	....	....	6	6
Hysteroconcha	....	....	2	1
Lamelliconcha	....	....	3	1
Cytherea	....	....	1	1
Ventricola	....	....	4	4
Saxidomus	2	....	....	....
Cyclinella	....	....	4	1
Chione	....	....	11	5
Timoclea	....	....	4	4
Lirophora	....	....	4	2
Anomalocardia	....	....	2	5
Venus	1	1	1	2
Marcia	1	....	1	....
Venerella	1	....	....	....
Protothaca	1	....	2	....
Callithaca	1	....	....	....
Liocyma	3	1	....	....
Venerupis	1	....	2	....
Gemma	....	1	....	1
Parastarte	....	....	....	1
Psephidia	2	....	....	....
Totals in each fauna	14	4	66	55
Species native to both oceans	....	....	2	....
	14	4	64	55
Total North American Veneridæ	....	....	....	137

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Family VENERIDÆ.

The subdivisions adopted are characterized as follows:

Subfamily DOSINIINÆ.

Hinge with three left and three or four right cardinals, usually with an anterior left lateral fitting into a pit in the opposite valve and sometimes a developed posterior right lateral. Siphons long and united to their tips; foot large, arcuate, without a byssus or byssal groove; shell usually orbicular and generally more or less compressed, with a distinct pallial sinus.

A. *Anterior and sometimes posterior laterals present, the lunule impressed, but not distinctly limited.*

Genus DOSINIOPSIS Conrad, 1864.

Type, *D. Meekii* Conrad. Eocene.

Shell orbicular, heavy, concentrically striated, with a thick, polished periostracum; lunule impressed, but not circumscribed distinctly, and there is no defined escutcheon; inner margins smooth; pallial sinus short, free, acutely angular, and ascending; hinge strong, with corrugated nymphs and a strong rugose left anterior lateral fitting into a rugose pit in the opposite valve; right valve with a stout distinct posterior right lateral, which fits into an excavated socket in the left valve.

This is the only genus of the family with a distinctly developed posterior lateral tooth, and if it were not for the number of cardinals and the presence of a pallial sinus it might be referred to *Cyprina*.

Subgenus **Æora** Conrad, 1870. Type, *Æ. cretacea* Conrad. Cretaceous.

This is still imperfectly known, but differs from *Dosiniopsis* chiefly by being smaller, more delicate, and of a more elongated form.

Subgenus **Pelecyora** Dall, 1902. Type, *Cytherea hatchetigbeënsis* Aldrich, 1886. Eocene.

Shell orbicular, with rugose nymphs, simple anterior lateral and socket; no posterior lateral; the pallial sinus narrow, angular, ascending; the cardinals entire except the right posterior one, which is bifid; otherwise as in *Dosiniopsis*, though the only known species is very much smaller than the known species of *Dosiniopsis*.

This group differs from *Dosiniopsis* by its smooth lateral and socket, and by the absence of the posterior lateral and socket, and by its relatively deeper pallial sinus. From *Æora* the same characters, as well as the nonbifid left cardinals and orbicular form, suffice to distinguish it. The rugosity of the nymphs is more like the semiradial rugæ in *Tivela* than the fine granulations of the type of *Dosiniopsis*.

B. *Anterior lateral tooth and a defined lunule present.*

Genus DOSINIA Scopoli, 1777.

Type *D. africana* Hanley (Le Dosin, Adanson, 1757).

This is *Cytherea* (sp.) Bolten, 1798; *Orbiculus α* and *β*, Megerle, 1811; *Arthemis* (Poli) Oken, 1815; *Asa* (Leach) Basterot, 1825; *Arctoë* Risso, 1826; *Exoleta* Brown, 1827; *Artemis* Conrad, 1832; *Arctoa* Herrmannsen, 1846; *Cerana* Gistel, 1848; *Assa* (Leach) Gray, 1851; *Amphithæa* Leach, 1852; but not *Dosina* Gray, 1838.

Section *Dosinia* s. s.

Lunule impressed, small; escutcheon narrow, elongate, flattish, bordered on each side by a ridge or keel, at which the concentric sculpture tends to become lamellose; middle cardinals often grooved or bifid, the other teeth smooth; pallial sinus angular, ascending, usually narrow and extended forward at least halfway from the posterior to the anterior adductor; valves moderately convex.

The form of the escutcheon differs in this group from an obscure flattening, often unequal in the two valves, to a distinctly keeled area with sculpture differing from that outside the boundary, but in the series of species almost every gradation between these forms may be observed.

Section *Orbiculus* Megerle, 1811. Type, *Venus exoleta* Linnæus.

In this section there is no escutcheon, the pallial sinus is very long and narrow, and the anterior lateral is strong.

Orbiculus α Megerle, founded on *Venus prostrata* Linnæus, is a typical *Dosinia*. Most of the generic synonyms cited under the genus were based on the common European species which is the type of this

section. The young do not retain any corrugations on the posterior cardinals.

Section *Austrodosinia* Dall, 1902. Type, *Cytherea anus* Philippi. New Zealand.

Lunule deeply impressed, escutcheon impressed and bordered by prominent keels; pallial sinus short and angular; anterior lateral and the pit into which it is received, and usually some of the anterior cardinal teeth sharply corrugated; the middle cardinals bifid.

This group is represented in New Zealand and Japan.

Section *Dosinisca* Dall, 1902. Type, *Artemis alata* Reeve.

Areas of the lunule and escutcheon pouting mesially, defined by a deep sulcus, forming a posterior wing which recalls *Phacoides*; sculpture of fine, rather distant, sharp lamellae, sometimes with radial striation; pallial sinus deep and angular.

This group is distributed in Australia and Japan.

Section *Dosinorbis* Dall, 1902. Type, *Artemis bilunulata* Gray. Japan.

Lunule and escutcheon deeply impressed, the former surrounded by a larger area bordered as is the escutcheon by a lamellated keel; valves compressed, beaks produced, sculpture on the middle of the disk obsolete, becoming lamellæ laterally; pallial sinus short, angular; right posterior margin grooved beyond the hinge plate, to receive the beveled edge of the opposite valve.

This large and remarkable species appears to be unique in the genus. In the young the dorsal margins pout on each side of the ligament.

Section *Dosinidia* Dall, 1902. Type, *Venus concentrica* Born.

Valves, suborbicular, subcompressed, white, with a sculpture of concentric grooving, never lamellose, furnished with an obvious periostracum; lunule small, impressed; escutcheon absent; pallial sinus ample, ascending, angular in front; posterior cardinals serrate or corrugated in the nepionic young, smooth in the adult.

This group is confined to the tropical and warmer temperate seas of America.

Section *Dosinella* Dall, 1902. Type, *Cytherea angulosa* Philippi. East Indies.

Valves suborbicular with a shallow flattish lunule; the escutcheon narrow, flattish, hardly defined; pallial sinus ample, ascending, deep, bluntly rounded at the anterior end; anterior lateral and posterior right cardinal teeth absent or obsolete.

There are a few small species in which the bight of the pallial sinus is rounded, but in this large form the contrast between the blunt rounded form and the angular form usual in the genus is so marked that, after some hesitation, taking the obsolescent hinge-teeth into consideration, it seemed advisable to separate it sectionally.

C. *Lateral teeth absent, no lunule or escutcheon.*

Genus CYCLINA Deshayes, 1849.

Type, *Venus sinensis* Gmelin. China seas.

Soft parts like *Dosinia;* shell orbicular, concentrically and radially striate, without lunule or escutcheon; inner margins crenate; pallial sinus angular, ascending; teeth as in *Dosinia*, but without laterals, the posterior right cardinal obsolete.

It is not *Cyclinus* Kirby, *Coleoptera*, 1837.

Genus CLEMENTIA Gray, 1842.

Type, *Venus papyracea* Gray.

Soft parts as in *Dosinia*, according to Woodward; valves thin, concentrically undulate, convex, without lunule or escutcheon; inner margins simple, sharp; pallial sinus subangular, ascending; three cardinal teeth in each valve, the posterior right cardinal bifid; lateral teeth absent.

This is *Blainvillia* Huppé, 1854, not of Desvoidy, *Diptera*, 1830.

Subfamily MERETRICINÆ.

An anterior lateral tooth present; though sometimes obsolete, traces of it can always be detected in normal specimens.

Genus GRATELOUPIA Desmoulins, 1828.

Type, *Donax irregularis* Basterot. Miocene.

Valves elongate-oval, concentrically striate; three cardinals in each valve, the posterior right cardinal fused with the nymphal rugosities; the pallial sinus long and acute, reaching to the vertical of the anterior lateral lamina.

Subgenus **Cytheriopsis** Conrad, 1865. Type, *Cytherea hydana* Conrad. Eocene.

Valves trigonal, recalling *Tivela*, the left posterior cardinal fused with the nymphal rugosities; the pallial sinus short and rounded.

This is not *Cytheropsis* McCoy, 1849, and if the two names are judged incompatible, might be called *Grateloupina*. It is probably the precursor of *Grateloupia* and *Tivela*.

Genus TRANSENNELLA Dall, 1883.

Type, *T. conradina* Dall.

Shell small, having the general form and coloration of *Tivela*, but a hinge with three cardinals in each valve, the middle left cardinal bifid, and an elongate left lateral received into a socket in the opposite valve; the hinge has no rugosities, the lunule but not the escutcheon is defined, internal margins sharply tangentially grooved with numerous sulci; the pallial sinus angular, free, obliquely ascending.

Tropical and subtropical waters of America; receding in time to the Miocene. This group is unique in the family in the peculiar sulcation of the inner margin, which is only paralleled elsewhere once among the Astartidæ. A Pacific coast species is viviparous.

Genus TIVELA Link, 1807.

Type, *Venus corbicula* Gmelin (= *V. mactroides* Born).

Shell porcellanous, solid, smooth externally with a dehiscent periostracum; the coloration variable with a tendency toward dark brown and purple; valves trigonal, subequilateral, with prominent beaks and a short ligament; lunule large, faintly defined, escutcheon not defined; pallial sinus small, free, rounded in front; hinge variable with anterior laterals and from three to six cardinals, partly rugose and some of which may be bifid. Habitat, subtropical and tropical seas.

Section *Tivela* s. s. Type, *Venus mactroides* Born.

Valves trigonal, with smooth interior margins, usually a pilose periostracum over a polished surface; cardinals varying in different species.

This is *Trigona* Megerle, 1811, not Jurine, *Hymenoptera*, 1807; and perhaps *Dollfusia* Cossmann, 1886, which I know only by figures. The group is unique in the variability and occasional large number of cardinals, which are perhaps due to splitting up of the originally single posterior cardinals.

Section *Pachydesma* Conrad, 1854. Type, *Donax stultorum* Mawe.

Shell very large and ponderous, with smooth interior margins and a thick vernicose periostracum; hinge with four cardinals in each valve.

This is *Trigonella* Conrad, 1837, not of Da Costa, 1778. It is a Californian type.

Section *Eutivela* Dall, 1891. Type, *E. perplexa* Stearns, Argentina.

Shell small, elongate-trigonal, with crenulate interior margins, thin, polished periostracum, three left and four right cardinal teeth.

This type points the way toward *Sunetta*.

Genus SUNETTA Link, 1807.

Type, *Donax scripta* Linnæus.

Shell variable in form, smooth or concentrically sculptured, polished, often with vivid coloration; with an impressed, unequally divided lunule, larger in the right valve, and a deeply excavated escutcheon; posterior end of shell shorter than the anterior; pallial sinus wide, short, and rounded; inner margins conspicuously crenate; three cardinals in each valve, and rather elongate anterior laterals.

Eocene of south Europe and tropical seas of the Old World.

Section *Sunetta* s. s. Type, *Donax scripta* Linnæus.

Shell elongate-ovate, more or less inequilateral, the edge of the posterior cardinals finely rugose; sculpture concentrically sulcate or striate.

This is *Cuneus* Megerle, 1811, not of Da Costa, 1776; and *Meroë* Schumacher, 1817.

Section *Solanderina* Dall, 1902. Type, *S. solandri* Gray.

Shell inflated, smooth, subequilateral.

Section *Sunettina* Jousseaume, 1901. Type, *S. sunettina* Jousseaume, *S. menstrualis* Menke, etc.

Shell suborbicular, compressed, smooth.

Genus GAFRARIUM Bolten, 1798.

Type (by elimination), *Venus pectinata* Linnæus.

Shell equivalve, subequilateral, with a simple or slightly sinuous pallial line; three cardinals in each valve, entire or faintly grooved, and the usual anterior laterals; surface sculptured. Tertiary and recent warm seas of the Old World.

Section *Gafrarium* Bolten, s. s.

Surface with strong, chiefly radial, more or less dichotomous sculpture, that of the posterior slope differing from the rest; valves moderately convex, umbones subcompressed with a narrow lunule and feebly defined escutcheon; pallial line simple, inner margins of the valves crenate, the ligament sunken but not immersed; middle left cardinal feebly grooved.

This is *Paphia* Oken, 1815, not Bolten, 1798, or Lamarck, 1801; *Crista* Römer, 1857; and *Circe*, species, of many authors.

?Section *Radiocrista* Dall, 1902. Type, *Venus pulcherrima* Deshayes, Journ. de Conchyl., VIII, 1860, p. 381, pl. XIV, figs. 1, 2. Tertiary.

Shell with the form of *Chionella* the disk and anterior part elegantly, regularly, concentrically sulcate; margins of the dorsal area behind separated from the sulcate area by strong radial ribbing; the lunule not definitely circumscribed, but with its margins thickened and surface concentrically striated or smooth; escutcheon elongate-ovate, equally parted between the valves, nearly smooth. Interior?

The horizon and internal characters of this remarkable fossil are unknown, but it is provisionally located here, pending further information.

Section *Gouldia* C. B. Adams, 1847. Type, *Thetis cerina* Adams.

Shell small, reticulately sculptured, the radials toward the ends of the valves, and the concentric sculpture in the middle of the disk stronger; there is no specialized posterior area; moderately convex, the umbones not compressed; pallial line slightly flexuous behind, cardinals and inner margins of the valves entire.

Warm-temperate and tropical seas.

This group is *Thetis* C. B. Adams, 1845, not of Oken, 1815, or Sowerby, 1826. It is not *Gouldia* Bonaparte (*aves*), 1850. It is the only representative of the *Gafrarium* or *Circe* group in American Tertiary or recent seas, and has not yet been found on the Pacific coast.

Subgenus **Circe** Schumacher. Type, *Venus scripta* Linnæus.

Shell compressed, with only concentric sculpture, with smooth compressed beaks, narrow lunule and escutcheon; pallial line simple, inner margins smooth; posterior right cardinal grooved; ligament deeply sunken, but not entirely immersed.

Section *Parmulina* Dall, 1902. Type, *Circe corrugata* (Dillwyn) Deshayes.

Shell with the umbonal region flattened and coarsely divaricately ribbed, the rest of the surface concentrically sculptured; disk (except the umbones) convex; pallial line slightly flexuous, inner margins finely crenulate; lunule and escutcheon narrow, flat, the ligament depressed; cardinals entire or faintly grooved.

Section *Circenita* Jousseaume, 1888. Type, *C. arabica* Lamarck.

Valves convex; surface feebly concentrically sculptured, the beaks not compressed; posterior slope without specialized sculpture; lunule distinct, narrow, escutcheon hardly defined; ligament hardly depressed; pallial line with a minute sinus, the inner margins of the valves entire.

Genus LIOCONCHA Mörch, 1853.

Type, *Venus castrensis* Linnæus.

Shell solid, porcellanous, suborbicular, smooth or concentrically sculptured, vividly colored; lunule sharply circumscribed, impressed, but no defined escutcheon; ligament almost immersed, pallial line slightly flexuous, inner margins smooth, anterior left and posterior right dorsal margins grooved to receive the beveled edge of the opposite valve; anterior lateral large and strong; three smooth, entire cardinals in each valve.

Tropical seas of the Old World.

Genus MACROCALLISTA Meek, 1876.

Type, *Venus nimbosa* Solander.

Shell ovate, microscopically radially lineated, with low concentric waves, or smooth, with vivid coloration and vernicose periostracum; a defined lunule, but unequally divided between the valves; no defined escutcheon; internal margins smooth, pallial sinus free, ample, pointed in front and horizontally directed; cardinals three in each valve, smooth and entire, except a bifid right posterior tooth.

Section *Macrocallista* s. s.

Shell much elongated, the pallial sinus short, the posterior cardinals slender and elongated.

The type is better known as *Cytherea* or *Callista gigantea* (Gmelin) Lamarck.

Section *Chionella* Cossman, 1886. Type, *Cytherea ovalina* Deshayes.

Shell ovate-trigonal; pallial sinus long; the posterior cardinals short.

This is *Chione* Gray, 1838, not Megerle, 1811, or Gray, 1851; *Dione* Gray, 1851, not of Hübner, *Lepidoptera*, 1816; and *Callista* Mörch, 1853, not of Leach, 1852.

Genus AMIANTIS Carpenter, 1863.

Type, *Cytherea callosa* Conrad.

Shell ovate, concentrically waved, with vernicose periostracum; lunule and a linear escutcheon, defined; inner margins smooth; pallial sinus ample, acute in front, free below, slightly ascending; anterior cardinal very thin; anterior laterals large and strong.

Section *Amiantis* s. s.

Shell with two obscure radial ribs internally, near the middle of the disk; posterior cardinals elongated, strong, the right one bifid, the other teeth entire; the posterior left cardinal and the edge of the right nymph rugose; the posterior right dorsal margin beyond the hinge plate grooved to receive the edge of the opposite valve. Californian.

This is called *Amyantis* by Stoliczka, 1871.

Section *Eucallista* Dall, 1902. Type, *Cytherea purpurata* Lamarck.

Shell with the posterior cardinals short; the opposite faces of the nymphs with interlocking rugosities; the teeth smooth; interior without radial ridges.

Lamarck himself called attention to the remarkable corrugated areas of this shell which recall those of *V. mercenaria*. It is a Brazilian species which has been confounded with one from west America.

Genus MERETRIX Lamarck, 1799.

Type, *Venus meretrix*, Linnæus.

Shell trigonal, plump, thin, nearly equilateral, smooth with a vernicose periostracum, a peculiar olivaceous tone of coloration; lunule and escutcheon not circumscribed or distinctly defined; three cardinals in each valve and well-defined anterior laterals; the middle left and two anterior right cardinals entire, smooth, the others grooved or bifid; right nymph and posterior left cardinal corrugated; anterior left and posterior right dorsal margins beyond the hinge plate sharply grooved to receive the edge of the opposite valve; internal margins smooth; the pallial line with a shallow arcuate flexuosity, but no angular sinus; ligament hardly depressed.

Distribution chiefly in the China seas, Japan, and the Indo-Pacific region.

This group is *Cytherea* (Lamarck) and *Cytherea* Roissy, 1805, and Lamarck, 1806; *Cytherea* Defrance, 1818; *Nympha* Mörch, 1853, not Fitzinger, 1826; and *Meretrix, ex parte*, Deshayes, 1853.

Genus CALLOCARDIA A. Adams, 1864.

Type, *C. guttata* A. Adams.

Shell ovate, plump, thin, concentrically striated with more or less involute umbones; pallial sinus nearly obsolete; lunule feebly circumscribed, not impressed, escutcheon not defined; left anterior lateral received between two obsolete laminæ in the opposite valve; three cardinals in each valve not radiating from a point under the umbo, on the dorsal valve margin; the two anterior left cardinals continuous above and separated from the valve margin by a sulcus; the anterior and posterior right cardinals similarly connected, and dorsally separated by a groove from the margin; the arch of the two left cardinals fits over the middle right cardinal, the arch of the outer right cardinals over that of the two left ones, so that the middle right and the posterior left cardinals remain isolated; the dorsal margins beyond the hinge plate, in front in the left and behind in the right, are grooved to receive the beveled edge of the opposite valve.

In this group the teeth retain in the adult state the conditions which normally obtain in the early stages of hinge development as shown by Bernard.

The group is identical with *Caryatis* (part) Römer, 1862, not of Hübner, 1816; *Veneriglossa* Dall, September, 1886; and *Atopodonta* Cossmann, October, 1886. It is distributed in tropical and temperate seas and goes back to the Eocene in time.

The type was named *Callocardia guttata* by A. Adams in 1864. In 1888 Mr. Sowerby renamed it *Cytherea isocardia* on account of the existence of a *Cytherea* (*Callista*) *guttata* of Römer. The latter, however, was not described until 1866, so that it does not antedate Adams's name. If Römer's form is entitled to specific rank, it will not require a new name, as under the present arrangement it will be referable to the genus *Macrocallista*, section *Chionella*.

Subgenus **Agriopoma** Dall, 1902. Type, *Cytherea texasiana* Dall, 1892.

This differs from the typical *Callocardia* by its large, heavy, and chalky shells, without the involute umbones or any color pattern, and by the presence of a deep and angular pallial sinus. It is more northern in distribution than *Callocardia* proper, and more limited in geographical range, though receding to the Eocene in America. The peripheral species indicate a transition in the cardinals of the right valve toward the conditions found in the following group:

Genus PITARIA Römer (em.), 1857.

Type, *Venus tumens* Gmelin.

Shell trigonal, plump, concentrically striate or rippled, with an inconspicuous periostracum and delicate coloration; lunule circumscribed,

but the escutcheon not defined; inner margins smooth, pallial sinus ample, elongate, somewhat ascending, pointed in front; middle cardinal stout, the others slender; the posterior cardinals feebly grooved, the others entire; the cardinals of the right valve discontinuous where they touch the dorsal margin and not separated from the latter by a groove; anterior lateral adjacent, distinct; nymphs and teeth smooth; dorsal margins grooved as in *Meretrix.* Widely distributed in the Tropics.

Römer's original name, *Pitar*, is a vernacular African word, not really entitled to be used without Latinization, for which, in 1862, he substituted *Caryatis*, which is preoccupied in Lepidoptera since 1816. It is probable that a Latinized form as above should be adopted for the group.

Section *Pitaria* s. s. Type, *Venus tumens* Gmelin.

Shell smooth or with concentric striation, usually convex, subtrigonal or ovate, with a pointed sinus.

Section *Hyphantosoma* Dall, 1902. Type, *Cytherea carbasea* Guppy, 1866. Oligocene.

Shell with zigzag sculpture on the surface like *Textivenus* Cossmann, of the Venerine series.

Section *Tivelina* Cossmann, 1886. Type, *Cytherea tellinaria* Lamarck. Eocene.

Shell pointed behind with a Tellina-like twist to the valves, which are concentrically striate; hinge as in *Pitaria;* pallial sinus short, bluntly rounded.

Subgenus **Hysteroconcha** Fischer, 1887. Type, *Venus dione* Linnæus.

Shell subtrigonal, plump, concentrically laminate; lunule and escutcheon defined by incised lines and impressed, the laminæ becoming spinose near the boundary of the escutcheon; shell with tinted coloration not in patterns; inner margins smooth, pallial sinus linguiform, ample, free, slightly ascending; hinge as in *Pitaria*, the edges of the nymphs finely granular and the stout middle cardinal sometimes obscurely channeled. Tropical American waters.

This is *Dione* Gray, 1847, not Gray, 1851, nor Hübner, 1816; and *Venus* Megerle, 1811, not of Lamarck, 1799.

Section *Lamelliconcha* Dall, 1902. Type, *Cytherea concinna* Sowerby.

Shell trigonal, subcompressed, concentrically ribbed or laminate, without spines; the edges of the nymphs smooth; otherwise like *Hysteroconcha.*

Tropical seas, especially in America.

Genus CYTHEREA Bolten, 1798.

Types (by elimination), *Venus puerpera* Linnæus, *V. rugosa* Gmelin, and *V. verrucosa* Linnæus.

Shell large and rotund, convex, with strong predominantly concentric sculpture with well-marked lunule and escutcheon, the latter unequally

divided, larger in the left valve; umbones plump, ligament deep seated; cardinals large and partly bifid; anterior lateral small, papilliform; inner margins crenate; pallial line with a short rounded sinus.

Subgenus **Cytherea** Bolten, s. s. Type, *Venus puerpera* Linnæus.

Shell large, reticulately sculptured, the right portion of the escutcheon produced over the sunken ligament; lateral tooth minute.

Tropical seas.

This is *Antigona* Römer, 1857, not Schumacher, 1817.

Section *Clausina* Brown, 1827. Type, *Venus verrucosa* Linnæus.

Shell large, strongly concentrically lamellose, with obscure divaricating radials toward the ends; right portion of the escutcheon not overlapping the ligament; pallial sinus small, narrow, angular.

Tropical and temperate seas.

This is *Venusarius* (Dumeril) Froriep, 1806 (not binomial); *Dosina* Gray, 1838; *Venus* Swainson, 1840, not Lamarck, 1799; *Callista* (Poli) Leach, 1852, not Mörch, 1853; *Callista* Fischer, 1887, but not *Clausina* Römer, 1857.

Section *Ventricola* Römer, 1857. Type, *Venus rugosa* Gmelin.

Shell large with strong, distant, evenly spaced concentric lamellæ, between which are smaller concentric threads; pallial sinus small, angular, lunule deeply impressed; right part of the escutcheon obsolete.

Tropical seas of both hemispheres.

Subgenus **Aphrodina** Conrad, 1868. Type, *Meretrix tippana* Conrad. Cretaceous.

Shell concentrically striated, with a circumscribed lunule, but no defined escutcheon; inner margins smooth, pallial sinus ample, free, ascending, rather rounded in front; hinge with three cardinals in each valve, the right posterior cardinal bifid; an elongate anterior lateral corrugated on both sides and received into a pit with similar corrugations; nymphs smooth.

This form wants the posterior lateral and the granular nymphs of *Dosiniopsis*, and differs from *Cyclorisma* by its form, the presence of an anterior lateral and a defined lunule.

Subgenus **Antigona** Schumacher, 1817. Type, *Cytherea lamellaris* Schumacher (+ *Dosina lamarckii* Gray).

Shell having the form and sculpture of a *Chione* (Megerle), but with a lamelliform well-developed anterior lateral entering a socket in the right valve; the posterior right cardinal broad and deeply bifid; pallial sinus small, triangular.

Schumacher's type has been confused with *Chione cancellata*, but an examination of his figures and references makes his meaning plain.

Section *Antigona* s. s.

Shell rather elongate, with profuse concentric lamellation crenulated by fine radial ribs; lunule deeply impressed, the ligament exposed, the overlap of the escutcheon small.

This is not *Antigonus* Hübner, 1816, or *Antigona* Römer, 1857.

Section *Artena* Conrad, 1870. Type, *Venus staminea* Conrad. Miocene.

Shell trigonal or short, with acute concentric laminæ, between which are minute elevated concentric lines; lunule not deep; escutcheon large, not overlapping; posterior right cardinal narrow, laminar; other features as in *Antigona*.

This section bears to *Antigona* much such a relation as *Ventricola* does to typical *Cytherea*, in the other subgenus. It was called *Artenia* by Tryon in 1884.

Subgenus **Circomphalus** Mörch, 1853. Type, *Venus plicata* Gmelin (= *V. dysera* Linnæus *pro parte*).

Shell cordate, compressed, with distant elevated reflected laminæ which have leaflike expansions near the posterior border; lunule and escutcheon, impressed, striate, sharply limited, unequally divided between the valves; ligament deeply sunken; inner margins crenate, pallial sinus small, triangular; anterior right and posterior left cardinals slender, laminar, entire, the others bifid; a minute pustular anterior left lateral present.

This is *Anaitis* Tryon, 1884, not of Duponchel, 1829, or Römer, 1857; and *Chione* Römer, 1857, not of Mörch, 1853. *V. calophylla* Hanley, also belongs here.

Subgenus **Lepidocardia** Dall, 1902. Type, *Chione floridella* Gray (+ *Venus africana* Philippi).

Shell small, compressed, donaciform, smooth or concentrically striated, polished; lunule defined, but there is no defined escutcheon; internal margins smooth; pallial sinus linguiform, pointed in front, horizontally directed, partly confluent with the pallial line below; dorsal margins beyond the hinge plate grooved; teeth delicate, the anterior laterals well developed, the posterior right and anterior two left cardinals more or less distinctly grooved.

Though compressed, this form recalls *Gomphina* by its external characters.

Genus SAXIDOMUS Conrad, 1837

Type, *S. nuttallii* Conrad.

Shell large, rude, chalky, ovate-quadrate, with low beaks, and concentric usually feeble sculpture; the ligament is strong and not depressed; there is no defined lunular area or escutcheon; internal margins smooth; pallial line with a deep, rounded sinus; hinge with three cardinals in each valve; the posterior right cardinal bifid; anterior laterals closely adjacent to the cardinals, one of the left ones often in line with the anterior cardinal.

Shores of the North Pacific.

This group has been generally misunderstood and placed, as by Deshayes, near *Tapes*. His group of radial sulcate *Saxidomus*, of 1853,

all belong to *Callithaca*. The anterior lateral is so close to the cardinals that it has been counted in with them. The animal is meretricine, with long, closely united siphons. The group on the Pacific coast recedes to the Eocene in time.

Subfamily VENERINÆ.

ANTERIOR LATERAL TEETH ABSENT.

Genus CYPRIMERIA Conrad, 1864.

Type, *C. excavata* Morton. Cretaceous.

Pallial line feebly flexuous behind.

Subgenus **Cyclorisma** Dall, 1902. Type, *Cyclothyris carolinensis* Conrad. Cretaceous.

Pallial line deeply sinuated.

This is *Cyclothyris* Conrad, 1875; not of McCoy, *Brachiopoda*, 1844.

Genus THETIRONIA Stoliczka, 1871.

Type, *Thetis major* Sowerby, 1826. Cretaceous.

Surface granulose; pallial sinus high, angular vertically ascending; no lunule or escutcheon. This is *Thetis* Sowerby, 1826, not of Oken, 1815.

?Subgenus **Thetiopsis** Meek, 1876. Type, *T. circularis* Meek and Hayden. Cretaceous.

Smaller and smoother, the sinus shorter and irregular at its anterior basal part.

This is *Tethiopsis* Fischer, 1887.

Genus MYSIA (Leach MS.) Lamarck, 1818.

Type, *Venus undata* Pennant.

Siphons separated; hinge with two right and three left cardinal teeth; a circumscribed lunule, but no escutcheon. European.

This is *Lucinopsis* Forbes and Hanley, 1848, but not *Mysia* Gray, 1847.

Genus CYCLINELLA Dall, 1902.

Type, *Dosinia tenuis* Recluz.

Three cardinal teeth in each valve; otherwise like *Mysia*. American.

This genus extends to the Oligocene in time.

Genus CHIONE Megerle, 1811.

Type, *Venus cancellata* Lamarck.

Three cardinal teeth in each valve; pallial sinus short, angular; lunule and escutcheon defined, sculpture cancellate, inner margins of the valves crenate; concentric sculpture dominant.

Subgenus **Chione** s. s. Type, *V. cancellata* Lamarck.

This is *Chiona* Mörch, 1853, and of Römer, 1857; *Circomphalus* Adams, 1857; and *Omphaloclathrum* Tryon, 1884, not Mörch, 1853. It is not *Chion* Scopoli, 1777; *Chionis* Forster, 1788; *Chione* Desvoidy, *Diptera*, 1830; *Chionea* Dalman, 1816; nor *Chione* Gray, 1838. In a few of the larger species like *C. gnidia*, a feeble fourth cardinal is sometimes present in the right valve below the ligament; and the right posterior dorsal margin behind the ligament is sometimes grooved to receive the beveled edge of the opposite valve. In *Gomphina* alone have I found any anterior grooving of the margin in the left valve. The siphons are separate and short, the cardinals entire or feebly channeled.

Section *Chione* s. s. (See above.)

Section *Timoclea* Brown, 1827. Type, *Venus ovata* Pennant.

Sculpture predominantly radial, the concentric element feeble, the escutcheon smooth; the middle left and two posterior right cardinal teeth grooved.

This is *Pasiphaë* Leach, 1852, not Risso, 1826; *Leukoma* Römer, 1857, and *Leucoma* Stoliczka, 1871, not of Stephens, 1829; *Cytherea* H. and A. Adams, 1857, not of Bolten, 1798; *Murcia* (part) Römer, 1857, not of Koch, 1835.

Section *Clausinella* Gray, 1851. Type, *Venus fasciata* Da Costa.

Sculpture of broad concentric waves and fine concentric striæ, the radials obsolete; the waves not pinched out behind; the ligament covered by the margin of the valves when closed.

This is *Zucleica* Leach, 1852.

Section *Lirophora* Conrad, 1864. Type, *Venus athleta* Conrad; a recent species is *V. paphia* Linnæus.

Sculpture of broad concentric waves, attenuated and often conspicuously lamellose distally; radially striate; ligament exposed; the edges of the right nymph and posterior left cardinal with interlocking rugosities.

This is *Clausina* Römer, 1857, not of Brown, 1827; *Anaitis* (*paphia*) Fischer, 1887, not of Tryon, 1884; and *Anaitis* (part) Römer, 1857, not *Anaitis* Duponchel, 1829.

? Section *Volupia* Defrance, 1829. Type, *V. rugosa* Defrance, Eocene of Hauteville.

Shell small, sculpture superficially resembling *Lirophora*, but with lunule and posterior area defined by a deep sulcus dividing the disk into three areas crossed by thick, swollen, concentric ribs; beaks high and curved; hinge of three teeth, of which one is bifid; pallial line not sinuated?

In placing this shell here I have followed Fischer, since the species has not been well figured and the descriptions given of it are far from clear. I have not been able to obtain specimens for examination. From the very obscure figure of Defrance I should have suspected

this shell to be Lucinoid and to belong somewhere in the vicinity of *Here* Gabb.

Section *Chamelea* Mörch, 1853. Type, *Venus gallina* Linnæus.

Sculpture of narrow, close concentric waves or low lamellæ, without distal lamellation or radial sculpture; teeth entire; ligament exposed; the escutcheon and lunule smooth.

This is *Ortygia* Brown, 1827, not Boie, 1826; *Hermione* Leach, 1852, not of Blainville, 1828; *Orthygia* Mörch, 1853; *Chamelaea* H. and A. Adams, 1857; *Marcia* (part) Römer, 1857, not of Koch, 1835, and probably *Parvivenus* Sacco, 1900.

Subgenus **Gomphina** Mörch, 1853. Type, *Venus undulosa* Mörch.

Valves more or less rostrate, the surface usually smooth and polished, inner margins entire; dorsal margins grooved and beveled beyond the hinge plate; the posterior right and two anterior left cardinals grooved; ligament exposed. Pallial sinus short, free, and rounded in front.

Section *Gomphina* s. s. Type, *V. undulosa* Mörch.

Valves usually heavy, solid, and very tumid; the lower edge of the right nymph and the upper edge of the left posterior cardinal with reciprocal rugosities.

This is *Marcia* (H. and A. Adams part) Chenu, 1862, and Tryon, 1884, not of Fischer, 1887; *Hemitapes* Stoliczka, 1871, not Römer (part) 1857; not *Gomphina* Chenu, 1862.

Section *Macridiscus*[a] Dall, 1902. Type, *Venus aequilatera* Sowerby.

Valves more equilateral, trigonal and compressed, less heavy and sometimes with feeble striation distally; nymphs and teeth entire, smooth.

This is *Gomphina* H. and A. Adams, 1857, not of Mörch, 1853.

Genus ANOMALOCARDIA Schumacher, 1817.

Type, *Venus fluctuosa* Linnæus.

Valves rostrate, with a vernicose periostracum, sculpture obsolete mesially; the inner margins crenulate, the ligament exposed, the lunule and escutcheon impressed; cardinal teeth entire, three in each valve, the anterior right cardinal feeble, sometimes obsolete; pallial sinus small, angular, sometimes nearly obsolete.

Section *Anomalocardia* s. s.

Surface with predominantly concentric sculpture, vernicose periostracum, and the adjacent surfaces of the posterior left cardinal and right nymph minutely rugose. America and West Africa.

This is *Triquetra* Anton, 1839, after Blainville, 1818, but not of Conrad, 1846; it is *Cryptogramma* Mörch, 1853.

Section *Anomalodiscus* Dall, 1902. Type, *Cytherea squamosa* Lamarck.

Surface with reticulate subequal sculpture, a dull papery periostracum, and the hinge without rugosities. Indo-China.

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[a] From *Macer*, not from *μακρος*.

Genus VENUS (Linnæus) Lamarck, 1799.

Type, *Venus mercenaria* Linnæus.

Shell large, heavy, earthy, trigonal; with faint radial and stronger concentric lamellar sculpture; lunule and escutcheon well defined; internal margins crenulate; pallial sinus small, triangular; there are two bifid cardinals in the left valve, one bifid and two anterior simple cardinals in the right valve, with a rugose area in each valve representing a supplementary cardinal below the ligament, the rugosities interlocking when the valves close; the ligament is strong and wholly exposed; the posterior dorsal margin of the right valve grooved to receive the edge of the left valve. The genus is American.

It is *Mercenaria* Schumacher, 1817, and *Crassivenus* Perkins, 1869.

Genus MARCIA (H. and A. Adams, 1857) Fischer, 1887.

Type *Venus exalbida* Dillwyn.

Shell large, subquadrate, concentrically lamellose and striated, without radial sculpture, and with a dull, earthy surface; internal margins smooth; pallial sinus small, angular, free; hinge with three left and four right cardinals, the middle ones larger and grooved above. Australasia and southern South America.

Subgenus **Marcia** s. s. (See above.)

This is a *Venus* without hinge rugosities, radial sculpture, or marginal crenation. There is a well-defined lunule, but no defined escutcheon; the ligament is exposed.

It is *Katelysia* (part) Römer, 1857, not of Tryon, 1884.

Subgenus **Katelysia** (Römer, 1857) Tryon, 1884. Type, *Venus scalarina* Lamarck.

Shell rounded-trigonal, subcompressed, very inequilateral, sculptured with concentric riblike ridges, sharper distally, polished, porcellanous, with no radial sculpture; coloration lively, anterior end sharper; lunule smooth, circumscribed, escutcheon defined only by absence of sculpture; ligament short, internal margins smooth; hinge plate buttressed between the pedal and adductor scars; three cardinals in each valve, the anterior right and posterior left slender, entire, the others grooved or bifid; the anterior left and posterior right dorsal margins beyond the hinge plate sharply grooved to receive the beveled edge of the opposite valve. South Seas.

Section *Katelysia* s. s. (See above.)

The inequilateral ovate form of these shells is quite striking. *Chamelea* Chenu, 1862, not Mörch, 1853; *Marcia* (part) Römer, 1857, not Koch, 1835; and *Catelysia* Fischer, 1887, are synonymous.

Section *Hemitapes* Römer, 1857. Type, *Venus rimularis* Lamarck.

Shell trigonal, tumid, with a keeled escutcheon and short, rounded pallial sinus.

This is otherwise essentially like the preceding section, but owing to the different form appears very distinct. It is not *Hemitapes* of Stoliczka, Tryon, and Fischer.

Section *Venerella* Cossmann, 1886. Type, *Venus hermonvillensis* Deshayes. Eocene.

Shell small, ovate, concentrically striate; lunule large, circumscribed, escutcheon not defined; internal margins smooth; pallial sinus small free, ascending, rounded in front; three cardinal teeth in each valve, the margin of the hinge plate excavated at the interspaces; posterior right cardinal long, bifid; the other teeth entire.

These forms are distinguished from the smaller species of *Katelysia* chiefly by the form and disposition of the teeth.

Section *Mercimonia* Dall, 1902. Type, *Venus Bernayi* Cossmann. Eocene.

Shell small, ovate, concentrically striate, rather tumid; hinge normal, the posterior left cardinal slender, not elongated; posterior right cardinal grooved; margins entire; the pallial sinus nearly obsolete.

This is *Mercenaria* Cossmann, 1886, not of Schumacher, 1817. The species included in Cossmann's list which possess a small but deep pallial sinus might be referred to *Venerella*, from which they hardly differ.

Section *Textivenus* Cossmann, 1886. Type, *Venus texta* Lamarck. Eocene.

Shell ovate, convex, sculptured by fine obliquely reticulate or divaricate subequal threadlike ridges; lunule small, circumscribed, escutcheon bordered by a radial ridge; internal margins smooth, pallial sinus small, angular, free; three cardinals in each valve, the right posterior cardinal broadly bifid; the right posterior dorsal margin behind the hinge plate grooved to receive the edge of the opposite valve.

Section *Samarangia* Dall, 1902. Type, *Venus quadrangularis* Adams and Reeve.

Shell rounded-quadrate, subcompressed, white, with a dull surface; sculpture of concentric striation, more forcible distally; internal margins smooth; lunule unevenly divided between the valves, smaller in the right valve; escutcheon not defined; pallial sinus moderate, angular in front, free below; three cardinals in each valve, the middle left and two posterior right cardinals bifid; hinge strong.

The species belonging to this group are massive and solid. *V. lenticularis* Sowerby is an example. The anterior left and posterior right dorsal margins are grooved behind the hingeplate to receive the beveled edges of the opposite valve.

Genus PAPHIA Bolten, 1798.

Type. *P. alapapilionis* Bolten (= *Venus rotundata* (part) Gmelin, *not* Linnæus).

Cardinals, three in each valve; the anterior right and posterior left cardinals entire, the others often bifid.

Subgenus **Paphia** s. s.

Valves elongate-oval, subcompressed, with close concentric riblets covered by a vernicose periostracum and without radial sculpture; coloration brilliant; escutcheon and lunule narrow, smooth, impressed, the lunule unequally divided, the right portion encroaching on the left; inner margins smooth; the pallial sinus free, ample, rounded in front, obliquely ascending.

The species are of warm temperate and tropical seas in the eastern hemisphere, and are reported from the Tertiaries of South Europe since the Eocene. *Eutapes* Chiamenti, 1900, and *Callistotapes* Sacco, 1900, are synonymous.

Section *Baroda* Stoliczka, 1871. Type, *Venus fragilis* D'Orbigny. Cretaceous.

Valves elongate, thin, with purely concentric sculpture; the posterior cardinals elongated, sometimes grooved, the others simple; pallial sinus ample, horizontal, rounded in front; margins entire.

This group appears to be the Mesozoic precursor of *Paphia*. The Tertiary *Taurotapes craveri* (Michelotti) Sacco, seems hardly distinct from *Baroda*.

Section *Icanotia* Stoliczka, 1871. Type *Psammobia impar* Zittel, Gosau.

This is stated to differ from *Baroda* only by the presence of more or less radial sculpture.

Section *Paratapes* Stoliczka, 1871. Type, *Venus textile* Gmelin.

Valves elongate, turgid, smooth or feebly concentrically sculptured; lunule circumscribed, narrow; escutcheon undefined; middle cardinals bifid as in *Paphia*; inner margins entire; pallial sinus obliquely ascending, small, squarish anteriorly.

This is *Textrix* Römer, 1857, not Sundeval, 1833.

Section *Protapes* Dall, 1902. Type, *Venus gallus* Gmelin (+ *V. malabarica* Dillwyn).

Valves trigonal, closely concentrically ribbed, with no radial sculpture; a vernicose periostracum; a large elongate impressed lunule, no differentiated escutcheon; smooth inner margins; an ample, obliquely ascending pallial sinus, rounded in front; the two anterior and the left posterior cardinals entire, the others bifid; all the teeth short and concentrated.

This is *Pullastra* Chenu, 1862, not Sowerby, 1826.

Subgenus **Tapes** Megerle, 1811. Type, *Venus literata* Linnæus.

Valves oblong, subcompressed, vertically expanding and subangular on the posterior dorsal margin; lunule set off by an incised line, the escutcheon defined by a carina, both long and narrow; surface concentrically grooved; internal margins smooth; pallial sinus ample, horizontal, free below, rounded in front; the posterior right and two anterior left cardinals bifid or grooved; colors lively, often with a dark lineated pattern on a paler ground.

Tropical and temperate waters of the Old World. *Parembola* Römer, 1857, is synonymous.

Section *Tapes* Megerle s. s. (See above.)

Section *Polititapes* Chiamenti, 1900. Type, *Venus aurea* Gmelin.

Valves oblong, plump, not angular above, behind; surface with fine concentric sculpture and obscure radial striation; lunule small, circumscribed, escutcheon not defined; pallial sinus short, ascending, free below, rounded in front; color delicate and variable.

The siphons are united for three-fourths of their length in *T. virgineus* which is not known to form a byssus. The group is *Tapes* Sacco, 1900, not Megerle, 1811.

Section *Pullastra* Sowerby, 1826. Type, *Venus pullastra* Montagu.

Shell oblong, tumid, blunt behind; valves finely reticulately sculptured, with hardly differentiated lunule or escutcheon; the latter nearly linear; inner margins entire; pallial sinus deep, ample, horizontal, rounded in front and confluent with the pallial line below; the two posterior right and middle left cardinals are bifid; coloration feeble. The siphons are three-fourths united in the typical species.

Section *Myrsus* H. and A. Adams, 1858. Type, *Tapes corrugatus* Deshayes.

Valves as in *Pullastra*, but the concentric sculpture is broken and corrugated, the shell more elongate, though, from its nestling habit, very variable in outline; teeth as in *Pullastra*, lunule obscure or not defined, the escutcheon with a feebly carinate margin; pallial sinus small, slightly ascending, free below and rounded in front; inner margins smooth; coloration dull and unattractive.

This is *Metis* Adams, 1857, not 1856; *Myrsopsis* (*pernarum* Bonelli) Sacco, 1900, from the Italian Tertiaries, differs but slightly.

Subgenus **Ruditapes** Chiamenti, 1900. Type, *Venus decussata* Linnæus.

Valves convex, oblong; surface dull and feebly colored; sculpture strong distally, more or less reticulate, the concentric ridges mosculating anteriorly and feeble on the middle of the disk; the radial sculpture stronger; inner margins smooth; pallial sinus large, free below, horizontal, rounded in front; lunule circumscribed, the escutcheon feebly defined; all the inner cardinals more or less bifid; the siphons wholly free from each other and a byssus present.

Temperate and tropical regions of the Old World. This is *Amygdala* Römer, 1857, not of Van Phelsum, 1774; *Cuneus* H. and A. Adams, 1857, but not of Da Costa, 1776. It is not *Amygdalum* Megerle, 1811.

Section *Ruditapes* s.s. (See above.)

Subgenus **Protothaca** Dall, 1902. Type, *Venus thaca* Molina (+ *V. dombeyi* Lamarck).

Shell ovate, convex, coloration white or dull; surface dull, reticulately sculptured, the radials usually stronger; sculpture more or less distinctly divided into three areas, the middle of the valves with chiefly radial, the anterior radial and scabrous, the posterior with irregularly concentric sculpture; lunule and escutcheon of the left valve, sharply circumscribed; in the type species the right valve shows no escutcheon and the margin partially overlaps that of the left valve but does not conceal the ligament; middle cardinals grooved or bifid; pallial sinus free, moderate, pointed in front; the inner margins sharply crenulated in the typical section.

Section *Protothaca* s. s. (See above.) The siphons are short and united, the foot hatchet-shaped and not byssiferous. The distribution of this group includes the west coast of America, Japan, and New Zealand (*V. costata* Quoy).

Section *Callithaca* Dall, 1902. Type, *Tapes tenerrima* Carpenter.

Sculpture delicate, uniform over the disk and reticulate except in distorted individuals; lunule feebly defined with no escutcheon; the dorsal margin not overlapping in the right valve; inner margins entire, otherwise as in *Protothaca*.

Distribution, Northwest America. The tropical species of *Protothaca* are maculated, the northern forms yellowish white, with a dull surface. There is no byssal groove and the papillose siphons are united to their tips in the type species. The group is *Saxidomus* β of Deshayes, 1853.

Genus LIOCYMA Dall, 1870.

Type, *Venus fluctuosa* Gould.

Shell small, white or unicolored, covered with a vernicose periostracum, and concentrically waved, without radial sculpture; lunule circumscribed, escutcheon absent; inner margins smooth; pallial sinus short, free, rounded triangular; three cardinals in each valve, the anterior right and posterior right, entire, the others bifid; siphonal tubes unequal, the anal shorter, both united to their tips; foot long and pointed, without a byssal groove; the mantle open ventrally and smooth edged.

Distribution, Boreal and arctic waters of the Northern Hemisphere.

The group was called *Lyocima* by Barrois in 1887, and the species were formerly referred to *Tapes*.

Genus VENERUPIS Lamarck, 1818.

Type, *Venus irus* Linnæus.

Valves elongate and subquadrate; sculpture radial with distant, prominent concentric lamellation; lunule and right half of the escutcheon absent, left half of the latter defined by a keel; ligament exposed; the pallial sinus short, ascending, free, blunt in front; internal margins smooth in the type species; there are three cardinals in each valve, the anterior right and posterior left entire and slender, the others broad and deeply bifid; the siphons are long, united for half their length and with papillose orifices.

The species of this group are nestlers and often deformed. They have been much confused with species of *Petricolidæ*.

The name has been spelled *Venerirupis* by Sowerby and *Venererupes* by Swainson. *Petricora* Latreille, 1827, may be identical, but *Irus* Oken, 1815, is a synonym of *Saxicava*.

Subfamily GEMMINÆ.

SPECIES VIVIPAROUS, MINUTE.

Genus GEMMA Deshayes, 1853.

Type, *Venus gemma* Totten.

Shell subtrigonal, with concentric sculpture, a short external ligament, and large lunule, but no escutcheon; inner margin of valves crenate; pallial sinus distinct, small, triangular; siphons separate, the branchial longer and papilliferous; an elongated posterior left and anterior right lateral tooth received into a groove on the margin of the opposite valve; foot linguiform, not byssiferous.

The genus belongs to the Atlantic coast of North America, but has been introduced on the Pacific coast with seed oysters. It is represented in the eastern Tertiaries.

It is *Tottenia* Perkins, 1869.

Genus PARASTARTE Conrad, 1862.

Type, *Astarte triquetra* Conrad.

Shell trigonal, with prominent elevated beaks, equilateral, heavy, with a short ligament and large lunule, but no escutcheon; surface smooth, brightly colored, with a vernicose periostracum; internal margins crenate; pallial line slightly flexuous behind, but with no definite sinus; right valve with a strong middle cardinal and two feeble ones; left valve with two strong cardinals, but no lateral teeth; dorsal margins outside the hinge plate feebly grooved to receive the edges of the opposite valve.

This genus is confined to the coast and Tertiaries of the southeastern United States.

It is *Callicistronia* Dall, 1883, *olim*.

Genus PSEPHIDIA Dall, 1902.

Type, *Psephis lordi* Baird.

Shell small, veneriform, polished, with faint concentric sculpture; beaks not prominent; valves inequilateral, with a narrow, feebly defined lunule and no escutcheon; inner margins not crenate; pallial sinus distinct, angular; hinge with three delicate entire cardinals in each valve, but no laterals; animal with the mantle edges fused below, the siphons short, simple; an anterior opening for the foot, which is not byssiferous.

This group is confined to the Pacific coast as far as known, and is represented in the Pacific Pliocene. It is *Psephis* Carpenter, 1864, not of Guenée, *Lepidoptera*, 1854. Carpenter named several species without specifying a type in 1864. In 1865 he selected *P. lordi* Baird as type, and for the first time gave a distinctive diagnosis of the genus. Part of the species, among those originally referred to the group, belong elsewhere. *P. tantilla* appears to be a *Transennella*, and *P. tellimyalis* is the nepionic young of *Petricola*.

EAST AMERICAN SPECIES.

DOSINIA (DOSINIDIA) CONCENTRICA Born, 1780.

Florida Keys (Conrad); Martinique, Porto Rico, Guadeloupe, Virgin Islands, Santa Cruz, and St. Thomas, West Indies; Colon or Aspinwall; Maracaibo to Rio de Janeiro, Brazil.

The *Venus concentrica* of Gmelin is a mixture of various species, the name is fixed by Born's figure, which represents the southern type. The *concentrica* of early American writers was the *D. discus* of Reeve. The *D. concentrica* of Reeve is the *D. elegans* of Conrad.

The present species is *Arthemis patagonica* Philippi, 1844; *Venus philippii* Orbigny, 1847; *Venus dilatata* Solander, 1797; and *Dosinia floridana* Conrad, 1866, was probably founded on a young specimen. *D. concentrica* is the analogue of the Pacific coast *D. ponderosa*

DOSINIA (DOSINIDIA) ELEGANS Conrad, 1846.

In the offshore warm water, near Cape Hatteras, North Carolina; at Charleston, South Carolina; east and west Florida, the Tortugas, Texas, and south to Yucatan and St. Thomas, West Indies.

This fine, flat, and evenly concentrically sculptured species was figured by Lister (pl. 288, fig. 124), and is one of those long confounded under the name of *concentrica*. The young were referred to *D. oborata* Conrad by Miss Bush in 1885.

DOSINIA (DOSINIDIA) DISCUS Reeve, 1850.

Cape May, Virginia, and south on the coast of the mainland to Vera Cruz, Mexico.

This is the most compressed and dark-colored of our East Coast species and has finer and closer striation than any of the others. It is the *Artemis* or *Dosinia concentrica* of the earlier American writers, but not of Born. The color which resides in the periostracum is frequently distributed in darker and lighter zones.

TRANSENNELLA CUBANIANA Orbigny, 1847.

Cape Florida to St. Croix, West Indies.

A small, usually pure white species, living in 8 to 30 fathoms, and especially abundant in Porto Rico. It was inadvertently and erroneously referred to *Gouldia* in the report on the Blake mollusks.

TRANSENNELLA STIMPSONI Dall, 1902.

Cape Hatteras, Egmont Key and south to Key West, in 15 to 31 fathoms.

White, with brown lineation or maculation externally, and orange or deep purple internally, in the central part of the valves. By an accident this species was figured[a] for the following species, which is a smaller and more rostrate shell. *T. stimpsoni* is the largest and prettiest of the genus so far recognized.

TRANSENNELLA CONRADINA Dall, 1883.

St. Andrew Bay, on the north coast of the Gulf of Mexico in western Florida, south to the Florida Keys and north on the east coast of Florida to Palm Beach, near low-water mark.

This peculiarly cuneate species has much the same range of color as *T. stimpsoni*, but is different in form.

TRANSENNELLA CULEBRANA Dall and Simpson, 1901.

Culebra Island, Porto Rico.

A specially trigonal, short form, white inside, and light yellow brown externally.

TIVELA ABACONIS Dall, 1902.

Abaco, Bahamas, and Vera Cruz, Mexico.

Shell small, subtranslucent, of a warm rose color, passing into white distally. It is notable for having only three cardinals in each valve.

TIVELA MACTROIDES Born, 1778.

Bahama Islands and through the West Indies and adjacent continental shores and south to Santa Caterina, Brazil.

This species may be white, or chestnut brown, or with brown rays on a lighter ground. The form is almost as variable as the coloration. The adults appear to have more tumid umbones and a longer and more

[a] Proc. U. S. Nat. Mus., XXIV, pl. XXXI, figs. 5 and 7.

pointed posterior end than the juvenile specimens. The species is the *Venus corbicula* of Gmelin, 1792; *Tivela vulgaris* of Link, 1807; *Trigona radiata* Megerle, 1811; *Venus turgens* (Solander MS.) Dillwyn, 1817; *Trigona fasciata* Schumacher, 1817, and the *Cytherea corbicula* of Lamarck, 1818.

TIVELA (MACTROIDES var.?) NASUTA Dall, 1902.

Santa Marta, Colombia; Baker.

Having the striped color pattern and tints of varieties of *mactroides*, this shell has a very much more elongated form and more delicate hinge. There is nothing in the collection which enables me to bridge the gap between the two.

TIVELA TRIGONELLA Lamarck, 1818.

West Indies, and the Gulf of Paria.

This little oval species appears to be rare. It is the *Trigona angulifera* of Gray, 1838, and perhaps the *Cytherea incerta*, Sowerby, 1851.

TIVELA BRASILIANA Dall, 1902.

West Indies; Santa Caterina, Brazil; Ihering. This form was at first supposed to be *T. bicolor* Gray, but after study it was found to differ, being a heavier and less angular shell, with the dorsal slopes less straight and the pallial sinus shorter and relatively smaller, though the shell attains a greater size than *T. bicolor*. The type is from Brazil; some young specimens from the Antilles appear to be the same.

It is not at all certain that the *T. dillwyni* Deshayes, 1853 (*T. mactroides* Sowerby, 1851), is not, after all, an extreme variety of *mactroides* Born; there is a specimen of *T. bicolor* Gray, in the collection, marked as from Florida, but it is doubtless adventitious.

TIVELA FULMINATA Valenciennes, 1827.

Coast of southern Brazil at Rio and Santa Caterina.

Arcuate, with brownish umbones and more or less zigzag tracery. It has a length, when adult, of 60 mm.

TIVELA (PACHYDESMA) VENTRICOSA Gray, 1838.

Southern coast of Brazil.

This fine species is figured from juvenile specimens in Römer's Monograph, and in all the manuals it is stated to come from China. Dr. von Ihering has repeatedly collected it from the coast of Brazil, and the Chinese habitat is certainly erroneous. One specimen in the United States National Museum measures 105 mm. in length, 90 mm. in height, and 70 mm. in diameter. It is usually white with a dehiscent vernicose periostracum.

TIVELA (EUTIVELA) PERPLEXA Stearns, 1891.

Argentine coast; and off the Rio La Plata, in 10 to 15 fathoms, muddy bottom.

Notable for its crenulated margins and yellowish-white coloration.

TIVELA (EUTIVELA) IHERINGI Dall, 1891.

Sao Paulo and Santa Caterina, Brazil, Ihering.

More delicate and arcuate than the last species, and mottled or banded with purplish brown on a paler ground color, the interior more or less purple.

GAFRARIUM (GOULDIA) CERINA C. B. Adams, 1845.

Cape Hatteras, North Carolina, and southward to Bermuda, the Antilles, and to 90 miles southwest of Cape San Roque, Brazil, from low water to 95 fathoms.

This was first described as *Thetis cerina* by Professor Adams.

GAFRARIUM (GOULDIA) BERMUDENSIS E. A. Smith, 1885.

Bermuda, Barbados, and Curaçao in 5 to 100 fathoms.

More convex, heavy, and more coarsely sculptured than *G. cerina* as a rule, but sometimes varying toward that species, which is also found in Bermuda.

GAFRARIUM (GOULDIA) INSULARIS Dall and Simpson, 1901.

Porto Rico, in 5 to 30 fathoms; also in the Oligocene of Bowden, Jamaica.

Smaller, more inequilateral, and destitute of the lively color painting characteristic of the two species above mentioned. *G. insularis* is of a grayish-white color.

MACROCALLISTA NIMBOSA Solander, 1786.

Beaufort, North Carolina, south to Cuba and west to Mobile on the Gulf coast.

This is *Venus gigantea* of Gmelin, 1792 (after Chemnitz, 1788); *Pectunculus nimbosus* "Humphrey," 1797; *Paphia ala-avis* Bolten, 1798; *Cytherea multiradiata* Menke, 1830; and *Callista* (*Macrocallista*) *gigantea* Meek, 1876.

This is the most showy of American Veneridæ, and the largest of its genus.

MACROCALLISTA (CHIONELLA) MACULATA Linnæus, 1758.

Cape Hatteras, North Carolina, and southward to the shores of the Gulf of Mexico, the Florida Keys, through the Antilles, and to the vicinity of Cape San Roque, Brazil.

It is the *Cardium trigonum* of Martyn, according to Arango.

AMIANTIS (EUCALLISTA) PURPURATA Lamarck, 1818.

Cuba (Arango) and southward to Brazil.

This is *Cytherea lubrica* Deshayes, 1853, but not of Broderip, 1835; and was named *Chione purpurascens* by Gray, 1838. It is not *Venus purpurata* Gmelin, 1792, but is *Venus brasiliensis* var. β of Gmelin.

CALLOCARDIA VESICA Dall, 1886.

Gulf of Mexico to Barbados, in 84 to 175 fathoms.

White and concentrically grooved with isocardia-like beaks. Described as *Cytherea (Veneriglossa) vesica*.

CALLOCARDIA (AGRIOPOMA) TEXASIANA Dall, 1892.

Coast of Texas from Galveston to Indianola.

Resembles the following species, but is larger, much more elongate, and with a narrower lunule. Described as *Cytherea texasiana*.

CALLOCARDIA (AGRIOPOMA) MORRHUANA Linsley, 1848.

Prince Edward's Island, and southward to the vicinity of Cape Hatteras, North Carolina, in 10 to 107 fathoms.

Rounded trigonal, earthy white, with fine inosculating, concentric wrinkling externally. This species has long been confounded with the fossil *Cytherea convexa* Say, 1824, not of Brongniart, 1811; which name was replaced by Conrad in 1833 by *C. sayana*. Both names have been applied to the present shell, which has also been called *C. sayii* by Perkins, 1869. *C. morrhuana* has lower beaks, a narrower and more delicate hinge plate, and is in general less trigonal than the Miocene fossil. Linsley's name was given to a very young shell, without description, and subsequently identified by Dr. Gould from Linsley's specimens. It has been proposed to use the name *Sayana* for the recent shell, but this is clearly inadmissible, and Conrad himself retained it for the fossil after he decided that the two were not identical.

CALLOCARDIA (AGRIOPOMA) ARESTA Dall and Simpson, 1901.

Porto Rico, in 12 to 30 fathoms.

More porcellanous, inequilateral, and rostrate than the preceding species.

CALLOCARDIA (AGRIOPOMA) ZONATA Dall, 1902.

North Carolina coast near Cape Hatteras, in 18 to 22 fathoms.

Small, trigonal, evenly concentrically grooved and zoned with yellow brown.

PITARIA ALBIDA Gmelin, 1792.

From the Florida Strait through the West Indies and on the northern shores of South America, in 4 to 25 fathoms.

An elongate, squarish, white species, with the anterior end somewhat attenuated, frequently confused with bleached valves of *P. fulminata*.

PITARIA FULMINATA Menke, 1830.

Cape Hatteras, North Carolina, to Bermuda, the Antilles, and Brazil, in depths varying from a few feet to 170 fathoms, the latter locality having afforded living young specimens.

This is supposed by Krebs to be the *Cytherea hebraea* of Lamarck, 1818.

This species appears to be very common in the West Indies. Normally it is white, with radial or zigzag painting of bright yellow brown, under a chalky periostracum. The dead valves, bleached and worn, are frequently taken for *P. albida*. It is the *Cytherea varians* of Hanley, 1844; *C. rubiginosa* Philippi, 1845; but not *C. fulminata* Philippi, 1845, or *Venus fulminata* Valenciennes, 1827. The latter is a *Tivela*.

PITARIA PENISTONI Heilprin, 1889.

Bermuda, and St. Thomas, West Indies.

A small thin oval shell, more or less painted with brown outside and with purple inside.

PITARIA SIMPSONI Dall, 1895.

West coast of Florida, at Tampa and Sarasota bays, low water to 26 fathoms.

Larger, more trigonal, and solid than the last species, but very similarly painted, though it is occasionally pure white. This is a modified descendant of the Tertiary species of *Hyphantosoma*.

PITARIA EUCYMATA Dall, 1889.

Cape Hatteras, North Carolina, and southward to the Antilles and Cape San Roque, Brazil, in 20 to 111 fathoms.

Short oval, inflated, elegantly distantly concentrically grooved, polished, and painted with brown and cream color and internally with rose; this rare species is one of the most elegant and attractive shells of the coast.

PITARIA MUNDA Römer, 1860.

St. Thomas, West Indies.

A young and dubious shell, as yet unfigured.

PITARIA (HYSTEROCONCHA) DIONE Linnæus, 1758.

Texas coast to Costa Rica and Colon; also the Antilles and Trinidad.

This beautiful and well-known shell has been fortunate in escaping with a single specific synonym, *Dione veneris* Deshayes, 1853, the other names which have been cited for it being derived from authors with no standing in binomial nomenclature, unless we except the

anonymous *Pectunculus aculeatus* of the Museum Calonnianum, in 1797.

A variety in which the spines are aborted is not uncommon.

PITARIA (LAMELLICONCHA) CIRCINATA Born, 1778.

The Antilles, the northern shores of South America, and southward to Santa Caterina, Brazil.

This shell can hardly be separated from the *P. alternata* Broderip, of the Pacific shores of South and Central America, and has been stated to occur on the west coast of Africa as the *Venus guineënsis* Gmelin, 1792. Other synonyms are *Cardium purpurea* Martyn, 1784, and *Venus rubra* Gmelin, 1792.

CYTHEREA (CYTHEREA) LISTERI Gray, 1838.

From Lake Worth, Florida, and the keys, southward through the Antilles, as far as Tortola and the Virgin Islands.

This has been erroneously identified with *V. reticulata* Linnæus and *V. crispata* Deshayes, 1853, and wrongly referred to the Indo-Pacific fauna by Deshayes. There is a dash of purple under the nymphs.

CYTHEREA (VENTRICOLA) RIGIDA Dillwyn, 1817.

Florida Keys to Rio Janeiro, including the West Indies; also in the Gulf of California.

This well-known shell is the *Venus rugosa* Gmelin, 1792, not of Linnæus, 1771; it is the *Pectunculus rigidus* Solander MS., 1798; *V. cincta* Gmelin, 1792, is probably the young, and Schröter wrongly identified our shell with *Venus casina*.

CYTHEREA (VENTRICOLA) RUGATINA Heilprin, 1886.

Cape Hatteras, North Carolina, the Gulf of Mexico and southeastward to Porto Rico in 26 to 85 fathoms; also fossil in the Florida Pliocene.

Shell resembling *C. rigida*, but with the primary concentric lamellæ more distant and the secondary lamellæ more distinct. The margin below the lunule is produced into a point.

CYTHEREA (VENTRICOLA) STRIGILLINA Dall, 1902.

From Key West, Florida, to Barbados, and 90 miles southeast of Cape San Roque, Brazil, in 20 to 100 fathoms.

Shell entirely white, much smaller than the preceding species, and with very much finer, though similar, sculpture. The lunule is also proportionately larger.

CYTHEREA (VENTRICOLA) CALLIMORPHA Dall, 1902.

Barbados in 76 fathoms; a young shell, perhaps identical, off Cape San Antonio, Cuba, in 300 fathoms.

Shell small, with a rosy flush internally and a yellow brown periostracum over a white disk. This species was identified doubtfully with Reeve's *Venus pilula* in the *Blake* report, but I am now confident that it is distinct. The sculpture resembles that of *C. strigillina*, but is less dense and prominent.

CYCLINELLA TENUIS Recluz, 1852.

Sao Paulo and Rio de Janeiro, Brazil. Guadeloupe, West Indies, Recluz; and northward through the West Indies to Cedar Keys, West Florida.

This was erroneously identified with *C. kroyeri* Philippi, in Poulsen's Catalogue. It is not the *Artemis tenuis* of Sowerby, of slightly later date than *A. tenuis* Recluz; it is smaller and more delicate than the West American species. *Lucinopsis gundlachi* Dunker, in Arango, 1878, is synonymous, and probably the unfigured *C. fragilis* Römer, 1860, from St. Thomas.

CHIONE (CHIONE) CANCELLATA Linnæus, 1767.

From Cape Fear, North Carolina, southward to Brazil, including Bermuda, the West Indies, and the adjacent coasts, in shallow water.

This very abundant and variable shell has naturally received many names, and by the early naturalists was confounded with other cancellated species of Linnæus and others. It is the *Venus dysera* and *ziczac* of various authors, but not of Linnæus; it is *V. cingenda* Dillwyn, 1817; *V. elevata* (and probably *V. inæqualis*) Say, 1822; *V. lamellata* Deshayes, 1853, in synonymy; and *Cardium bicolor* Martyn, 1784. It is the *Venus lamarckii* of Beau, but not of Gray, the *V. ziczac* of Mörch and Krebs, but not of Linnæus; the *V. maculosa* of Gmelin, 1792.

CHIONE (CHIONE) SUBROSTRATA Lamarck, 1818.

Miami, Florida, and the Keys, and south to the Abrolhos Islands, off the Brazilian coast, and Rio Janeiro, in shallow water; also on the shores of the Pacific at Mazatlan, etc.

This is also the *Venus beaui* Recluz, 1852; and *Venus portesiana* Orbigny, 1846. It is the *V. crenifera* of Carpenter in the Mazatlan Catalogue, and Sowerby, 1835; probably also *Venus lunularis* Philippi, 1844 (as of Lamarck), but not of Lamarck, 1818.

CHIONE (CHIONE) MAZYCKII Dall, 1902.

Cape Hatteras, North Carolina, and southward to the vicinity of Cape San Roque, Brazil, in 15 to 127 fathoms.

The bright rose color of the interior and its quadrate form are the most striking characteristics of this small but pretty species. It was cited in Bulletin 37, United States National Museum, as *Venus lamarckii* Gray, the young of which it much resembles, but the latter is an Indo-Chinese species, and has a different hinge.

CHIONE (CHIONE) INTAPURPUREA Conrad, 1849.

Cape Hatteras, North Carolina, and southward to Florida and the Keys and westward on the mainland coast to Texas. Also fossil in the Pliocene of Florida.

This elegant species is the *Venus punctulata* of Conrad, 1843, not of Valenciennes; and the *V. lacunata* Reeve, 1863.

CHIONE (CHIONE) PUBERA Valenciennes, 1827.

West Indies and northern shores of South America. This fine species has been much confused with an East Indian form for which the name of *Cytherea crenata* Gmelin, 1792,[a] should be retained. The present species is a *Chione*, and is the *Venus crenulata* of Sowerby, 1853, and Reeve, 1863, but not of Dillwyn, 1817, or Deshayes (ex parte), 1853. A young specimen with the valves somewhat worn is figured on Plate 267 of the Encyclopédie Méthodique (figs. 4, 4a), and to this in the explanation of these plates by Bory St. Vincent, in 1827, page 152, is attached the name of *Venus pubera* Valenciennes. To figs. 3 and 3a is given the name of *Venus punctata* Valenciennes, but it is not the *Venus punctata* of Linnæus. Conrad, in 1843, cited fig. 4 as *Venus punctulata* Valenciennes,[b] thus committing a double error. Our shell is *Venus eximia* Philippi, 1847, and *V. superba* Guppy, 1875. *V. lacunatus* Reeve, 1863, is probably a young specimen of it.

It is remarkable for its resemblance to the Oriental *Cytherea* referred to, but can at once be distinguished by the absence of the vestigial anterior lateral. *Venus doumeti* Bernardi, 1860, may be a rather short young specimen of this species.

CHIONE (TIMOCLEA) PECTORINA Lamarck, 1818.

The Antilles, and southward to Brazil at Sao Paulo.

It is *Venus elegans* Gray, 1828.

CHIONE (TIMOCLEA) GRANULATA Gmelin, 1792.

Belize, and throughout the West Indies to Brazil.

This is *Venus marica* Born, 1780, but not of Linnæus, 1768; *C. lavacrum* Bolten, 1798; and *Venus plumbea* Reeve, 1864. It is *V. violacea*, and perhaps *V. purpurata*, Gmelin, 1792. Lamarck and Bory St. Vincent have confused numbers of the figures on the plates of the Encyclopédie Méthodique, so that the same figure is made to stand for *V. granulata* Gmelin, *V. cardioides* Lamarck, and *Venericardia radiata* Valenciennes, 1827. *V. cardioides* is probably not an Antillean species, and may be identical with *Tapes histrionica* Sowerby, as well as *Cytherea cardilla* Lamarck.

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[a] *Venus crenulata* Chemnitz, Conch. Cab., VI, 1782, p. 370, pl. XXXVI, fig. 385.

[b] Proc. Acad. Nat. Sci. Phila., I, p. 311.

CHIONE (TIMOCLEA) GRUS Holmes, 1858.

Cape Hatteras, North Carolina, and south and west on the mainland coast to Yucatan, in 12 to 63 fathoms. Also fossil in the Pliocene.

This little shell has been very generally confused with *Venus pygmæa* Lamarck, but it is perfectly distinct. It may perhaps be *V. antillarum* Orbigny, 1853; but this can not be positively determined at this time. It is *Venus parva* Sowerby, 1854, but not of Sowerby, 1829, or Munster, 1836; and it was named *Venus trapezoidalis* by Kurtz in 1860. The animal has two subequal, closely united, fringed siphons, two-fifths as long as the shell.

CHIONE (TIMOCLEA) PYGMÆA Lamarck, 1818.

Florida reefs, and throughout the Antilles.

This little shell was named *Venus inæquivalvis* by Orbigny in 1853. It is of a white color, with brown maculations and a brown spot on the hinge, with coarser sculpture and attaining a larger size than *C. grus*.

CHIONE (LIROPHORA) PAPHIA Linnæus, 1767.

West Indies and southward to the coast of Brazil, in shallow water, and thence to 30 fathoms, usually on a sandy bottom.

This fine and well-known shell is the *Pectunculus vetula* of Da Costa, 1778, but it is not the *Venus paphia* of Pulteney. It is probably the shell listed as *C. affinis* Gmelin, by Poulsen, 1878.

CHIONE (LIROPHORA) LATILIRATA Conrad, 1841.

Cape Hatteras, North Carolina, south to Rio Grande do Sul, Brazil, in 10 to 124 fathoms.

Distinguishable from *C. paphia* by its ribs, which are not pinched off behind and do not bear any elevated expansions. It is *Venus varicosa* Sowerby, 1853, and *V. alveata* Bush, 1885, not of Conrad.

CHIONE (GOMPHINA) KOCHII Philippi, 1843.

A single valve from Belize was collected by the Rev. Mr. Stanton, but it is believed to be derived from ballast, since no living specimens were obtained.

ANOMALOCARDIA BRASILIANA Gmelin, 1792.

Wilmington, North Carolina, and south to the West Indies and to Rio de Janeiro, Brazil.

It is the *Venus flexuosa* Born, 1780, not of Linnæus, 1767; the *V. macrodon* of Hanley, 1843, and Sowerby (fig. 88), 1853; *V. lunularis* Lamarck, 1818; and *Cryptogramma brasiliana* of Römer, 1867. This is the common *Anomalocardia* of the West Indies, a shell very variable in form and color.

ANOMALOCARDIA CUNEIMERIS Conrad, 1845.

From Lake Worth, Florida, and on the shores of the continent south to Cartagena, Colombia. It is not yet authentically reported from the islands of the West Indies.

This is *Venus punctifera* Gray, in Sowerby, 1853; *V. rostrata* Sowerby, 1853, a young shell; *V. flexuosa* Chenu, 1862, but not of Linnæus, 1767, nor Born, 1780. It is *V. macrodon* Reeve, in part. It is smaller, more slender, and more delicate than the *V. macrodon* of Lamarck.

ANOMALOCARDIA LEPTALEA Dall, 1894.

Lagoon at Watling Island, Bahamas. Small, very thin, curiously depauperate from its extraordinarily saline habitat. The inner margins are entire and there is no trace of radial sculpture. The coloration is very variable.

ANOMALOCARDIA MEMBRANULA Römer, 1860

St. Thomas, West Indies; Römer.

Elongate like *A. leptalea*, but with numerous (23) concentric lamellæ, obsolete posteriorly, and of a ferruginous brown, with white specks; the inner margin crenulated. Perhaps a variety of the next species.

ANOMALOCARDIA PUELLA Pfeiffer, 1846.

Punta de Maya, Matanzas Bay, Cuba.

Small, whitish, with radiating brown flecks between concentric lamellæ; internally reddish brown. The lamellæ are persistent and about 13 in number, in a shell 11 mm. long. The inner margin is crenulated. *Venus auberiana* Orbigny, 1853, is probably identical.

VENUS MERCENARIA Linnæus, 1758.

Living from Bay of Chaleurs, Gulf of St. Lawrence, and at Sable Island, southward, locally, to Cape Cod, and thence generally southward to the Florida Keys, westward to the Mississippi Delta, and, sparsely, on the coast of Texas as far west as Corpus Christi Bay. Fossil from the early Miocene to recent times.

This is the *Venus mercenaria* of Spengler, 1785, and subsequent authors; the *V. meretrix* Bolten, 1798, not of Linnæus, 1758; *Mercenaria violacea* Schumacher, 1817; *M. cancellata* Gabb, 1860; *M. antiqua* Verrill, 1875; and *Crassivenus mercenaria* Perkins, 1869.

VENUS MERCENARIA var. NOTATA Say, 1822.

New England to Georgia.

This form is marked by zigzag brown blotches and lines, and is destitute of the purple coloration internally. It is *Venus obliqua* Anton, 1837, and *V. cyprinoides* Anton, 1839.

VENUS MERCENARIA var. CANCELLATA Gabb, 1860.

A rare variety, described from the Miocene, and occasionally found living, in which the medial smooth space of the type is concentrically divided into flat riblets by shallow grooves, the riblets being also radially sulcate.

VENUS MERCENARIA var. RADIATA Dall, 1902.

Similar to the last, except that the smooth medial area is not concentrically sulcate.

VENUS MERCENARIA var. ALBA Dall, 1902.

In this form the interior is like *notata*, and the exterior destitute of colored lineation.

VENUS CAMPECHIENSIS Gmelin, 1792.

Chesapeake Bay and southward to Cuba; westward to Texas and southward to Yucatan, near low-water mark. Fossil from the Miocene to recent faunas.

This is the largest species of the family and the most ponderous, characterized by high inflated beaks, blunt ends, white shell, frequently with zigzag brown lineation in the young externally, and a surface sculpture of dense, low, thin concentric lamellation. The young usually begin in a somewhat quadrate form, with more distant lamellation, without a purple border internally, but sometimes a purple flush in the cavity of the beaks. It passes through a series of mutations analogous to those of *V. mercenaria*.

The young shells about 2 inches or so in diameter have been named *Venus calcarea* by Philippi, 1844; *V. tenuilamellata* Sowerby, 1853, and *V. fulgurans* Tryon, 1865. Gmelin's type was also an adolescent shell. The recent adult has been named *V. præparca* Say, 1822; *V. mortoni* Conrad, 1837, and *V. alboradiata* Sowerby, 1853. To the various mutations exhibited by the species in the fossil state the following names have been given: *V. tetrica* Conrad, 1838; *V. permagna* Conrad, 1838; *V. capax* Conrad, 1844; *V. submortoni* Orbigny, 1852; *Mercenaria obtusa* Conrad, 1866; *M. cuneata* Conrad, 1868, and *M. carolinensis* Conrad, 1875.

VENUS CAMPECHIENSIS var. ALBORADIATA Sowerby, 1853.

Shell with broad brownish rays on a paler ground.

VENUS CAMPECHIENSIS var. QUADRATA Dall, 1902.

Shell small, quadrate, thin, compressed, and unicolorate, usually yellowish white.

VENUS CAMPECHIENSIS var. TEXANA Dall, 1902.

Texas coast.

Shell suborbicular, inflated, with the concentric lamellæ toward the middle of the disk coalescent, forming broad, more or less inosculating, low, flat-topped ribs with polished tops, sometimes showing the brown lineations of the younger stages.

VENUS CAMPECHIENSIS var. TETRICA Conrad, 1838.

Shell with the size and dense surface sculpture of the typical form but the produced trigonal outline of *V. mercenaria*.

VENUS CAMPECHIENSIS var. CUNEATA Conrad, 1868.

Shell subtrigonal, very thick, with very prominent beaks, and very short and blunt, the ancithesis of the elongated variety *tetrica*.

VENUS CAMPECHIENSIS var. CAROLINENSIS Conrad, 1875.

Shell much like the normal form but with the lamellæ more or less coalescent in the middle of the disk and not flattened or polished. This occurs living and also in the miocene of North Carolina, from which it was described.

LIOCYMA FLUCTUOSA Gould, 1841.

Arctic, Spitsbergen, and Greenland seas, and the Sea of Okhotsk; southward to the Gulf of St. Lawrence and Nova Scotia, on the Atlantic coast.

The typical form is creamy white. A variety *brunnea*, of rich chestnut or yellow brown, is noted from the Gulf of St. Lawrence. It is the *Venus astartoides* (Beck MS.) Philippi, 1849, but not of D'Archiac, 1847. *Tapes arctica* Reeve, 1864, from the "Arctic Seas," though not this species, may belong to this group.

GEMMA GEMMA Totten, 1834.

Labrador to Woods Hole, Massachusetts; New York Bay?

Flattish and irregularly rippled concentrically. The type is more or less purple, varying to pure white, which forms the variety *Manhattanensis* Prime, 1862. The species is *Gemma totteni* Stimpson, 1860, and *Tottenia gemma* Perkins, 1869.

GEMMA (GEMMA var.?) PURPUREA H. C. Lea, 1842.

Cape Cod to the Bahamas and Texas.

More inflated, trigonal, and with uniform concentric threads sharply defined. It is *Gemma concentrica* Dall, 1889. The color is variable, but usually paler than *G. totteni*.

PARASTARTE TRIQUETRA Conrad, 1845.

From Hillsboro Inlet, on the east coast of Florida, south to the Keys, and on the west coast north to Cedar Keys. Also fossil in the Pliocene.

Small, polished, very elevated, purple and white. Though much resembling *Gemma*, it can easily be discriminated by its smooth and more elevated shell.

NOTES ON AND DESCRIPTIONS OF EAST AMERICAN SPECIES.

DOSINIA (DOSINIDIA) ELEGANS Conrad.

Plate XII, fig. 6; Plate XIII, fig. 7.

Owing to the confusion that has involved this species a figure of it was thought to be desirable.

The figured shell is from Florida. Cat. No. 6120, U.S.N.M.

DOSINIA (DOSINIDIA) DISCUS Reeve.

Plate XII, fig. 1; Plate XIII, fig. 1.

No good figure of this species being available in any recent American publication, one is now supplied. The specimen is from South Carolina. Cat. No. 54094, U.S.N.M.

TRANSENNELLA CONRADINA Dall.

Plate XIII, fig. 5.

Cytherea (*Transennella*) *conradina* Dall, Proc. U. S. Nat. Mus., VI, 1883, p. 340.

A figure drawn from a specimen of *T. stimpsoni* Dall, as noted below, was inadvertently published under this name, so I now give a figure taken from one of the typical specimens. Cat. No. 64437, U.S.N.M.

TRANSENNELLA CUBANIANA Orbigny.

Plate XIII, fig. 4.

Venus cubaniana Orbigny, Moll. Cubana (Sagra), II, 1853, p. 278, pl. xxvi, figs. 44–46.

An enlarged figure of this species is given, which shows a few brown flecks dorsally, though this species is usually pure white. It is from Florida. Cat. No. 54135, U.S.N.M.

TRANSENNELLA STIMPSONI, new species.

Merctrix conradina Dall, Proc. U. S. Nat. Mus., XXIV, pl. xxxi, figs. 5, 7.

Shell small, rounded trigonal, rather plump, polished, painted with purple-brown on a white ground externally, the lunule, and central portion of the disk internally usually purplish; beaks prominent, incurved, small; lunule defined by a sulcus, elongate, narrow; escutcheon not defined; beaks five-fourteenths of the length from the anterior end.

which is rounded, with the dorsal slope rather flat; posterior end attenuated; hinge normal, the posterior left cardinal obscure, thin, consolidated with the nymph; internal margins tangentially sulcate; pallial sinus deep, narrow, somewhat rounded in front. Length 14; height 10.5; diameter 7 mm.

Type locality.—Egmont Key, Florida. Cat. No. 54100, U.S.N.M.

The shell is marked by fine concentric lines of growth, and by a few, irregularly distributed, stronger concentric sulci, which become evanescent toward the middle of the disk.

TIVELA ABACONIS, new species.

Plate XIII, fig. 3.

Shell small, subtranslucent, deep rose color at the beaks and in the middle of the disk, becoming paler toward the margins; beaks high, pointed, subcentral; shell moderately inflated, the ends rounded, the base gently arcuate; surface polished; hinge delicate; the teeth small, three cardinals in each valve, the anterior lateral elongate, thin, distant; pallial sinus short, wide, rounded; length, 11; height, 8.2; diameter, 6 mm.

Type locality.—Abaco, Bahamas, I. Greegor. Cat. No. 103551, U.S.N.M.

The shell is smaller, more delicate, more equilateral, and of a different color and texture from *T. trigonella* Lamarck, which is the only species comparable with it and which is white and opaque with a conspicuous periostracum.

TIVELA NASUTA, new species.

Plate XII, fig. 2.

Shell of moderate size, solid, nearly equilateral, somewhat rudely concentrically striated, with a reddish-brown polished periostracum; shell substance white, with numerous pale purple radii, the dorsal posterior margin near the end dark brown within and without; beaks pointed, dorsal slopes nearly straight; lunule impressed, defined by a distinct incised line; anterior end rounded, posterior end narrower, almost rostrate; hinge solid, with four cardinals, the anterior lateral lamelliform, prominent; pallial line with a short, small, rounded sinus. Length, 32.5; height, 25; diameter, 17 mm.

Type locality.—Santa Marta, Colombia; Baker. Cat. No. 153377, U.S.N.M.

By its rudely striated surface and produced posterior end, this seems to differ from the other Antillean forms.

TIVELA BRASILIANA, new species.

Plate XII, fig. 3.

Shell subtriangular, flattish, with high, pointed, opisthogyrate beaks; cream color with darker yellowish zones; surface smooth; lunular region impressed, lunule narrow, elongate, pouting a little at the junction of the valve margins; posterior slope straight, flattened, with a short ligament; interior pale yellow brown; hinge with five right cardinals, the posterior pair rugose; the anterior lateral adjacent, strong; the pallial sinus rounded, about as large as the posterior adductor scar. Length 40; height 34; diameter 20 mm.

Type locality.—Santa Caterina, Brazil. Cat. No. 125468, U.S.N.M.

This peculiarly flat and triangular form recalls the *T. planulata* Sowerby, of the Pacific coast.

CALLOCARDIA (AGRIOPOMA) ZONATA, new species.

Plate XII, fig. 4.

Shell small, thin, arcuate, with a dull surface, whitish with concentric zones of yellow brown; surface concentrically striated or sulcate with wider interspaces, forming low riblets; beaks high, inflated, their apices small, anteriorly directed, lunule large, cordate, defined by a sulcus; no visible escutcheon; ends rounded, base prominently arcuate; interior porcellanous, with a small ascending angular pallial sinus; hinge verging toward *Chionella*. Length 23; height 18.5; diameter 14 mm.

Type locality.—United States Fish Commission station 2608, in 22 fathoms, sand, off the coast of North Carolina. Cat. No 92015, U.S.N.M.

CYTHEREA (VENTRICOLA) STRIGILLINA, new species.

Plate XII, fig. 5.

Shell rotund, inflated, grayish white; beaks prominent, their apices anteriorly directed; lunule deeply impressed, cordate, striated; disk covered with low, uniform, slightly recurved thin primary concentric lamellæ, about 1 millimeter apart, the interspaces with much finer and smaller secondary lamellæ; there is no defined escutcheon, but the posterior dorsal slope, as usual, is less prominently lamellose; hinge strong, with large teeth, the anterior lateral large, and the posterior cardinal on the right valve bifid; pallial sinus very small, wide, and angular; internal margins of the valves finely crenulate. Length 45; height 39; diameter 32 mm.

Type locality.—United States Fish Commission station 2317, in 45 fathoms, coral, off Key West, bottom temperature 75° F. Cat. No. 95668, U.S.N.M.

This species is easily distinguished by its fine close sculpture and pale grayish color from either of the other American species of *Cytherea.* The interior is pure white.

CYTHEREA (VENTRICOLA) CALLIMORPHA, new species.

Plate XIII, fig. 6.

Shell small, globose, covered with a thin yellowish periostracum over a white shell with a salmon-colored flush internally; beaks full, prominent, the apices turned forward; lunule cordate, circumscribed, evenly striated; surface with about 27 primary concentric lamellæ having a T-rail section, the flat interspaces having 6–8 extremely fine low concentric threads, crossed by fine radial striation; escutcheon limited by an obscure ridge, ending in a subangular projection of the margin; in front of the ridge is a wide shallow radial depression; hinge well developed; posterior right cardinal long, distant from the others and bifid; middle right cardinal deeply bifid; anterior lateral small, papilliform; interior surface polished, with a salmon-colored flush behind the beaks; pallial sinus small, sharply angular, ascending; inner margins finely crenate. Length 16; height 14.5; diameter 12 mm.

Station 272, in 76 fathoms, at Barbados, West Indies, United States Coast Survey steamer *Blake.* Cat. No. 64292, U.S.N.M.

The peculiar form of the primary lamellæ renders them very liable to fracture, and if broken off they leave no visible trace, and the surface appears uniformly concentrically threaded, since the basal attachment of the primaries is no wider than the normal width of the secondary threads.

CHIONE MAZYCKII, new species.

Plate XIII, fig. 2.

Shell small, subrostrate, with low distant concentric lamellæ crossing flat radial ribs, those radials in front of the middle later becoming double, while the ribs behind the middle remain single; all the ribs are separated by subequal smooth interspaces except near the anterior margin, where interstitial threads appear; the concentric lamellæ become laminate, especially on the right valve, near the posterior end; lunule distinct, lanceolate, striated; escutcheon defined by a keel, striated, the right half somewhat overlapping the other, painted with brown streaks or entirely brown; disk white with pale-brown or rose-colored radial bands and occasional darker-brown flecks; interior rose color with white near the end and basal margins; hinge normal, with a rose-colored ray below a very short ligament; pallial sinus very small and blunt, inner margins crenulated. Length, 14.2; height, 11.2; diameter, 8 mm.

Type locality. United States Fish Commission station 2616, off

Cape Fear, North Carolina, in 17 fathoms, sand. Cat. No. 92022, U.S.N.M.

This pretty little species is easily discriminated by its form and color from *C. cancellata* at any stage of growth. It is named in honor of Mr. W. G. Mazyck, of Charleston, South Carolina.

NOTES.

The following *nomina nuda* have been cited in connection with the East American fauna: *Venus lanceata* "Say" and *V. metastriata* "Say," *Venus punctulata* "Valenciennes" and *Cytherea decorata* Conrad, by Conrad, 1846; *Cytherea bella* and *Venus orbicularis* Kurtz, 1860. Names of West American species have been mistakenly applied to those of the east coast, or West American specimens have been wrongfully attributed to eastern localities as follows: *Cytherea pinnosa* Sowerby, *Tapes grata* Say, *Venus pulicaria* Broderip, *Chione cingulata* and *Artemis kroyeri* Philippi, *Chione asperrima* Sowerby, and *Callista exspinata* Reeve. Exotic species wrongly given east American habitats are: *Venus crenata* "Chemnitz," *Cytherea affinis* "Gmelin," Sowerby, 1853, *Cytherea kingii* Gray and *C. modesta* Philippi, *Dosinia dilatata* Philippi, *D. lucinalis* Lamarck, *D. cyclas* Römer, and *D. kraussii* Römer.

Species from exotic localities like St. Vincent, Cape Verde Islands, of which the names are repeated in American waters, have been catalogued as from the latter; such are *Dosinia radiata* Reeve and *Venus verrucosa* Linnæus. *Cytherea occulta* Say, 1822, is unfigured and known only by the original description. Most of the names of American *Tivela* have been indiscriminately cited from both coasts, the species being difficult to discriminate and genetically connected. *Venus foveolata* Sowerby, 1853, was described from Martinique, but Deshayes adds to the locality "China." It does not come from both places, but has not been authentically reported from the West Indies since Sowerby's time. Locard, in the report on the Talisman expedition mollusca, reports it from St. Vincent, Cape Verde Islands, in 35 fathoms. *Tapes occidentalis* Reeve, 1864, appears to be identical with a Bombay species, figured on the same plate. It is certainly not West Indian. The ascription of *Venus decorata* Broderip and Sowerby, 1835, by Reeve in 1863, to the West Indies, is erroneous. It is of a strictly oriental type and comes from the Moluccas. I suspect *Venus sallei* Reeve, 1864, of a similar origin, notwithstanding the fact that it is said by Reeve to come from "Bird Island, in the Caribbean Sea." There are a great many "Bird Islands" scattered over the world, and this shell, so far as I may judge from the figure, has an Indo-Pacific aspect.

Dosinia turgida Reeve, 1850, through confusion with *Cyclinella tenuis* Recluz, has erroneously acquired an American habitat.

WEST AMERICAN SPECIES.

DOSINIA (DOSINIDIA) PONDEROSA Gray, 1838.

Payta, Peru, northward to the Gulf of California, and to north latitude 26° 30′ on the west coast of Lower California; in the Pleistocene north to San Pedro, California.

This, the largest and finest of the genus, recalls somewhat the Atlantic *D. concentrica*. It is the *Artemis ponderosa* Gray, 1838, the *Artemis gigantea* Sowerby (in Philippi, 1847), and the *Venus cycloides* Orbigny, 1847. *Artemis distans* Sowerby, 1852, if from Puerto Potrero, Costa Rica, as suggested by Carpenter, may be identical with the young of this species.

DOSINIA (DOSINIDIA) DUNKERI Philippi, 1844.

West Colombia, at Santa Elena; Panama Bay; the Galapagos Islands; and northward to Mazatlan and the head of the Gulf of California; also to Magdalena Bay, on the west coast of Lower California.

This is *Dosinia simplex* Hanley, 1845, not of A. Adams, 1855, and *Cytherea pacifica*, Troschel, 1845, not *Venus pacifica* Dillwyn, 1817.

DOSINIA (DOSINIDIA) ANNÆ Carpenter, 1857.

Mazatlan and the Gulf of California.

This is less tumid, more elongated and smoother than *D. Dunkeri*, and has a more horizontal pallial sinus. The small *D. nanus* Reeve, 1850, was probably based on a very young specimen of this species.

CLEMENTIA SOLIDA Dall, 1902.

Topolobampo, on the west coast of Mexico; collected by E. Daniels.

This is a large and squarish species, with a more solid shell and less degenerate hinge than any of the others heretofore known. It has somewhat the aspect externally of *Saxidomus giganteus*.

TRANSENNELLA TANTILLA Gould, 1853.

Sitka Harbor, Alaska, and southward to Lower California at Todos Santos Bay, in 3 to 16 fathoms; also fossil in the Pleistocene of Santa Barbara, California.

Trigonal, moderately convex, rather elongate; white, with or without zigzag brown painting, usually with the posterior dorsal slope dark purple within and without.

This species is viviparous and was referred by Carpenter to his genus *Psephis* on that account, but has a wholly different hinge. It has been referred to *Venus*, *Trigona*, etc., but on the basal margin has the sulcations of *Transennella*, though less distinct than in the typical species. The Pleistocene specimens were named *Venus rhysomia* by Gabb in 1861.

The more northern specimens are smaller and more oval than those from Santa Barbara, the type locality; and the purple streak is reduced to a more or less distinct flush, which is occasionally wholly absent. These characters, however, seem hardly pronounced enough to deserve a varietal name.

TIVELA PLANULATA Sowerby, 1829.

Gulf of California, Gulf of Tehuantepec, and southward to the coast of Ecuador.

This includes the variety *suffusa* Sowerby, 1835; *Donax lessoni* Deshayes, 1835; *Cytherea undulata* Sowerby, 1851, a color variety; and *C. mactroides* Lamarck, 1818, not of Born, 1778. It is extremely variable in coloration, but maintains fairly well its compressed triangular form.

TIVELA HIANS Philippi, 1851.

Magdalena Bay, Lower California, to Valparaiso, Chile.

This form, described from Mazatlan, is more elongated and rostrate, has a more livid purplish coloration and a very distinct gape behind, by which it is separated from *T. planulata*.

TIVELA ARGENTINA Sowerby, 1835.

West Mexico and south to Panama.

Distinguished by its yellowish-white color, thin shell, and arcuate form attenuated at both ends. It is *Cytherea æquilatera* Deshayes, 1839.

TIVELA ARGUTA Römer, 1864.

Gulf of California to Panama.

Shell small, thin, and oval, recalling *T. trigonella* of the Antilles.

TIVELA GRACILIOR Sowerby, 1851.

Puntarenas, Costa Rica.

This is a species of peculiar form, with fine elevated radial lines anteriorly. It is not the shell figured by Römer under this name.

TIVELA BYRONENSIS Gray, 1838.

Scammon's Lagoon, Lower California and the Gulf of California, and southward to the coast of Ecuador.

This is *T. radiata* Sowerby, 1835, not of Megerle, 1811; *Venus solangensis* Orbigny, 1847; *Cytherea stultorum* Menke, 1847, not of Mawe, 1823; *Cytherea corbicula* Menke, 1847, not of Lamarck, 1818; *Cytherea pulla* Philippi, 1851, and perhaps *C. intermedia* Sowerby, 1851, and *T. elegans* Verrill, 1870. *Trigona humilis* Carpenter, 1857, appears to be the young fry of this species; *T. semifulva* Menke is a nearly white variety, and *T. hindsii* Hanley, 1844, is a striped and latticed color form of the young shell. It is the most common of the Pacific coast species and the analogue of *T. mactroides* of the Antilles.

TIVELA DELESSERTI Deshayes, 1854.

Scammon's Lagoon (young?): Cape St. Lucas, the Gulf region, and south to Acapulco.

This is the *Cytherea nitidula* Sowerby, 1851, not of Lamarck, 1818; the young fry were named *Tivela marginata* by Carpenter, but I do not find that this name has ever been defined in print. It is an elegant polished shell, delicately painted with light purplish brown on a cream-colored ground.

TIVELA (PACHYDESMA) STULTORUM Mawe.

Santa Cruz, California, and south to Ballenas Lagoon, Lower California, and perhaps to Mazatlan.

This is the *Donax stultorum* of Mawe in 1823, but not the *Tivela stultorum* of Menke in 1847; the *Trigonella crassatelloides* Conrad, 1837; *Cytherea solidissima* Philippi, 1851; *C. æquilatera* Römer, 1857, not of Deshayes, 1839; *C. lamarckii*, *C. stultorum*, and *C. crassatelloides* of Reeve in 1864. This is the largest and finest species of the genus, and is well known to most conchologists under the name of *Pachydesma crassatelloides*. A related fossil, *P. inezana*, is said by Conrad to exist in the California Miocene.

MACROCALLISTA (CHIONELLA) SQUALIDA Sowerby, 1835.

Cerros Island, Pacific coast of Lower California, to the Gulf and southward to Peru, in 7 to 27 fathoms.

Chione biradiata Gray, 1838, and *Cytherea chionæa* Menke, 1847, are synonymous. The Philippine *C. elegans* Koch, in Philippi, 1844, has been united with them, but is probably distinct. The species is much like *Macrocallista chione* of Europe, but less attractive. It is the analogue for the Pacific coast of *M. maculata* Linnæus, of the Antilles.

MACROCALLISTA (CHIONELLA) AURANTIACA Sowerby, 1831.

Gulf of California, Cape St. Lucas, and southward to Guayaquil, in 10 to 18 fathoms.

More compressed, redder, and with a dark and dull instead of translucent vernicose periostracum, compared with *M. squalida*. It was first figured and named in Sowerby's Genera of Shells, Part XXXIII, but Hanley's name of *aurantia* given thirteen years later has been more generally used.

MACROCALLISTA (CHIONELLA) PANNOSA Sowerby, 1835.

Cape St. Lucas, the Gulf of California, and southward to Valparaiso, Chile.

This pretty little species is extremely variable in its color pattern. *Cytherea lutea* Koch, in Philippi, 1845, is synonymous.

MACROCALLISTA (CHIONELLA) PUELLA Carpenter, 1864.

Gulf of California and south to Acapulco.

Marvelously like *M. pannosa* in color and form, but always a smaller and thinner shell, with other distinctive characters.

These two species have a great similarity to the Eocene type on which the section *Chionella* was founded.

AMIANTIS CALLOSA Conrad, 1837.

San Pedro, California, to Cape St. Lucas, in shallow water.

This elegantly sculptured, pure white species is well known. *Dione nobilis* Reeve, 1863, is based on a specimen somewhat more rounded than usual.

CALLOCARDIA (AGRIOPOMA) CATHARIA Dall, 1902.

Ballenas Bay, on the Pacific shore of Lower California, to the Gulf of California and southward to the Bay of Panama in 7 to 66 fathoms.

White, somewhat chalky, sharply concentrically striated, with a subcuneate outline and papyraceous periostracum. The analogue of the West Indian *C. aresta* Dall and Simpson, 1901.

PITARIA NEWCOMBIANA Gabb, 1865.

Monterey, California, to Clarion Island and the Gulf of California in 15 to 31 fathoms.

Thin and delicate, with zigzag brown markings and a papery periostracum when fresh.

PITARIA TOMEANA Dall, 1902.

Bay of Panama (Galapagos Islands?), and Tome, Chile, in about 10 fathoms.

The apparent analogue of *P. fulminata* Menke of the Atlantic fauna, but without color painting on the specimens so far obtained.

PITARIA CONSANGUINEA C. B. Adams, 1852.

Panama.

Belongs in the group with *C. albida*, etc., but has radial brown markings and pinkish umbones. I have not seen it.

PITARIA POLLICARIS Carpenter, 1864.

Gulf of California, Cape St. Lucas, and south to Callao, Peru.

A fine, large species, the young with brown painting, the adults mostly polished white. It is *Dione prora*, variety, of Reeve, 1863, but not of Conrad; *Cytherea obliquata* Römer, in part, but not of Hanley, 1844. The true *prora* comes from the Hawaiian Islands.

PITARIA UNICOLOR Sowerby, 1835.

Humboldt Bay, Lower California, and south to Panama.

Somewhat compressed, the concentric sculpture obsolete in the middle of the disk, the color uniform white or brownish. The brown variety is *Chione badia* Gray, 1838, and *Cytherea ligula* Anton, 1839. *Cytherea lubrica* Sowerby, 1835, is perhaps identical. Some specimens are almost rostrate.

PITARIA VULNERATA Broderip, 1835.

Magdalena Bay, on the Pacific shore of Lower California, to the Gulf of California and south to the Bay of Panama.

Remarkable in its violet zones of coloration and for having the inner margins often obscurely crenulate, a feature not known elsewhere in the genus. It is the *Cytherea tricolor* of Pease (MS.) according to Römer, 1867. The young are maculated with brown and the adults sometimes radially lineate with the same color; young specimens of elongate ovate form, which have not assumed the violet rim, have a very different aspect from the mature shell or the normally orbicular young ones.

PITARIA (HYSTEROCONCHA) LUPANARIA Lesson, 1832.

Ballenas Bay, Pacific coast of Lower California, the Gulf of California, and southward to Payta, Peru.

A larger but less elegant analogue of the Antillean *P. dione* Linnæus, easily recognizable by the violet spots at the base of the spines. It appears, as from China, under the name of *Cytherea semilamellosa* Gaudichaud, in the Récueil des Coquilles non figurées of Delessert in 1841. It has also been regarded by several authors as a mere variety of *P. dione*. *Dione exspinata* Reeve, 1863, is a mutation in which the spines are abortive. Northern specimens usually have the concentric sculpture carried evenly across the disk, but in the south a variety is common in which the ribs are obsolete on the posterior half of the disk. The name is frequently misspelled *lupinaria*. It is *Cytherea dronea* Gray, 1833.

PITARIA (LUPANARIA var.) MULTISPINOSA Sowerby, 1851.

Realejo, Central America, and southward to Payta, Peru.

This is a small form in which the concentric sculpture and spines are sharp and crowded, while the coloration is less intense, so that the whole shell is more like *P. dione* than the better developed normal form is. There seems to be insufficient reason for regarding it as a distinct species. The *Cytherea brevispinosa* Sowerby, 1851, seems to have been founded on a single bleached specimen in which the inner

row of spines is wanting and the outer row abortive. *Dione brevispinata* and *D. brevispina* Deshayes, 1853, are variants of this name. *Callista longispina* Mörch, is doubtless a mutation of this species.

PITARIA (HYSTEROCONCHA) ROSEA Broderip and Sowerby, 1829.

Gulf of California to Panama.

Reddish brown, flattish, with only hints of spines, which lie in a white streak radiating from the umbo. *Cytherea lepida* Chenu, 1847, is synonymous.

PITARIA (LAMELLICONCHA) CONCINNA Sowerby, 1835.

Magdalena Bay, Pacific coast of Lower California, to the Gulf of California, southward to Panama Bay, the coast of Ecuador and Payta, Peru.

Donaciform or even rostrate, with concentric round-edged ribs, white, with radial streaks of brown; all brown; or all white.

Cytherea affinis Broderip, 1835, and *Venus paytensis* Orbigny, 1847, are synonymous.

C. tortuosa Broderip, 1835, is a white specimen with the ribs more irregular than usual. According to Römer, *C. suppositrix* Menke, 1849, may be this species.

PITRARIA (LAMELLICONCHA) CIRCINATA Born, var. ALTERNATA Broderip, 1835.

Gulf of California to Payta, Peru.

When fully developed this is larger, more convex, and with more distant concentric ribs than any Atlantic specimens I have seen. Immature specimens are often hardly distinguishable. For synonymy see Atlantic list.

The original *alternata* of Broderip was founded on two shells, perhaps distinct from each other. The description was taken from one and the suggestion of the name from the other, which last is represented by Reeve's figure 28*b*, in the Iconica, 1863. Those writers who have had an opportunity to examine Broderip's types agree in referring them to *P. circinata* as a variety; from the figures I should suppose them to be closer to *P. concinna*. Römer, in 1868, figures the second or white form with alternating ribs (pl. XXXVI, fig. 2), which is more like *P. circinata* than the other.

PITARIA (LAMELLICONCHA) CALLICOMATA Dall, 1902.

Bay of Panama, in 7 to 30 fathoms.

White and rather earthy, with primary concentric lamellæ, from one to three secondary smaller lamellæ intervening between each two primaries. It is more elongate, with a longer and narrower lunule than *circinata* and more oval than *alternata*.

CYTHEREA (VENTRICOLA) FORDI Yates, 1890.

Santa Barbara Islands, California, and south to the Gulf of California and to Panama Bay, in 13 to 58 fathoms.

This fine species is near to but quite distinct from *Venus toreuma* Gould[a] a Polynesian species, with which Carpenter doubtfully united it, and by whose name it has passed for some years. It reaches a a length of 65 mm., and is easily recognized by its *Isocardia*-like form, concentric undulations and sharp radial striæ.

CYTHEREA (VENTRICOLA) MAGDALENÆ Dall, 1902.

Off Magdalena Bay, west coast of Lower California, in 36, and in Panama Bay in 18 fathoms.

The analogue of *C. strigillina* Dall, of the Atlantic fauna, but thinner, less inflated, with more delicate sculpture, and pale yellowish coloration spattered with brown flecks.

CYTHEREA (VENTRICOLA) RIGIDA Dillwyn, 1817.

Gulf of California in 9½ fathoms, sand, off the peninsular coast near La Paz. Also in the Atlantic fauna.

The discovery of this well-known Atlantic shell by the United States Fish Commission steamer *Albatross* in the Gulf of California was a surprise; but the specimen, 85 mm. in length, does not seem to differ constantly in any respect from the West Indian shells. The synonymy is summarized in the Atlantic list. It is not *Venus rigida* Gould, 1850. The Pacific shell was named *Venus isocardia* by Verrill in 1870.

CYTHEREA (FOVEOLATA VAR.?) LEPIDOGLYPTA Dall, 1902.

Purchased at Acapulco by W. H. Dall in 1868.

This species has an extraordinary resemblance externally to *Venus campechiensis* of the same size, but it has the hinge of *Cytherea*. It also resembles the figure of *Venus foveolata* Sowerby, 1853, a species referred to both Martinique and China by Deshayes. The raised lamellæ are minutely, transversely, closely striated, but there is no radial interstitial sculpture. The shell is of a yellowish white color. It was purchased with a lot of beach shells, all West American, at Acapulco.

CYTHEREA (CYTHEREA) MULTICOSTATA Sowerby, 1835.

Gulf of California and south to Panama Bay, in moderate depths of water; also at the Galapagos Islands.

Belonging to the group of *C. listeri*, but more oval and with somewhat different sculpture. *Venus thouarsi* Valenciennes, 1846, is probably synonymous. The anterior lateral is usually obsolete in adult specimens, but distinct in the young.

[a] *Venus toreuma* Gould, July, 1850, from Mangsi Island; + *V. crebrisulca* Sowerby, 1853, and *V. jukesii* Deshayes, 1853, Luzon, and Port Essington, North Australia.

SAXIDOMUS NUTTALLII Conrad, 1837.

Baulinas Bay, California, and south to San Diego.

There are two species of *Saxidomus* on the coast, of which one has brownish markings near the beaks in the young, and a trace of purple internally on the upper posterior margin. The other is all white or yellowish. The present species is rather thin, but reaches a length of 120 mm., and is usually rudely concentrically sulcate. It is the *Venus maxima* Anton, in Philippi, 1846; the *Saxidomus aratus* Gould, 1861, also called by him in the index *S. oratus* (1862); while the young, with its colored markings, he named *Tapes gracilis* in 1855. Conrad's type was young, 50 mm. long, but his allusion to the color markings settles the identity of the species referred to.

SAXIDOMUS GIGANTEUS Deshayes, 1839.

The Aleutian Islands, from Attu eastward to Kadiak, and southward to the Bay of Monterey, California.

There is no sufficient evidence of the occurrence of this species on the Asiatic coast. It is solid, broad, and heavy; the young are yellowish white; the adult attains a length of 130 mm., and the concentric sculpture is much less pronounced than in *S. nuttallii*. The exterior is sometimes fulvous, but the interior is always white. Specimens which have nestled in rock crevices are usually stunted and distorted. The synonymy has been much confused. It is the *Venus sulcata* of Potiez and Michaud, 1844, but not of Montagu, 1803, or Lamarck, 1818. It was named *Venerupis gigantea* by Deshayes, and has been confounded with *S. squalidus* Deshayes, a South American species, and *S. nuttallii* Conrad.

CYCLINELLA SUBQUADRATA Hanley, 1845.

St. Elena, West Colombia; Panama Bay; Mazatlan, and northward to Guaymas, on the Gulf of California, in 7 to 25 fathoms.

Arthemis saccata Gould, 1851; *Cyclina saccata* Deshayes, 1853; *Artemis tenuis* Sowerby, December, 1852, not of Recluz, June, 1852 (and not *Artemis turgida* Reeve, 1850), are synonymous.

CYCLINELLA KROYERI Philippi, 1847.

Chile and Peru; Salango, West Colombia, in 9 fathoms; and the Gulf of California in 14 to 26 fathoms.

Artemis macilenta Reeve, 1850, appears to be synonymous. It is *Venus kroyeri* Philippi, 1847, but not *Lucinopsis kroyeri* Poulsen, 1878. It is smaller, more orbicular, and proportionately flatter than *C. subquadrata*.

CYCLINELLA PRODUCTA Carpenter, 1856.

Panama Bay, Bridges.

This species, represented by a unique valve in the Cumingian collection, is said to be produced behind like *Cyrena maritima* C. B. Adams.

CYCLINELLA SINGLEYI Dall, 1902.

Guaymas, on the Gulf of California, and at the delta of the Yaqui River near Guaymas, Singley.

This is a moderate sized but turgid species with fine, sharp striation, heavy shell, and the posterior adductor scar very large.

CHIONE (CHIONE) FLUCTIFRAGA Sowerby, 1853.

San Pedro, California, to the Gulf of California and on the shores of the Gulf.

The sculpture of the middle of the disk is strong in youth, obsolete or absent in older stages; some large oblique specimens recall in sculpture *Venus mercenaria*. The species is *Venus callosa* of Sowerby and Deshayes, in 1853, but not *Cytherea callosa* Conrad, 1837; *Dione gibbosula* Deshayes, 1853, and Reeve, 1863, and *Venus cortezi* (Sloat MS. in) Carpenter, 1864, are synonymous.

CHIONE (CHIONE) UNDATELLA Sowerby, 1835.

San Pedro, California, to the Gulf of California and southward to Guayaquil.

A species larger than but varying like *C. cancellata*, with many names; a large series of good specimens leaves no doubt as to the consolidations needed. The characteristics are the generally inflated and closely concentrically lamellose form. The young have the lamellæ more distant, but they are always thin and sharp. The type is painted with angular brown lines like *Venus notata;* young specimens with dark brown blotches are Carpenter's *Venus excavata* of 1856. Specimens without brown painting, adult, and conspicuously lamellose are *V. simillima* Sowerby, 1853. The left half of the escutcheon is usually smooth; the right half may be smooth or lamellose. When coarsely lamellose we have the variety *neglecta* Sowerby, 1839. Carpenter is much confused in his synonymy of these species. *V. nuttallii* Conrad, 1837; *V. entobapta* Jonas, 1845; *V. perdix* Valenciennes, 1846; *V. bilineata* Reeve, 1863; and *V. subrostrata* Reeve, 1863, not of Lamarck, 1818, are synonymous. *V. sugillata* Reeve, 1863, recalls a young acidulated specimen.

CHIONE (CHIONE) SUCCINCTA Valenciennes, 1833.

San Pedro, California, the Gulf of California and south to Panama.

This is another variable species, about which Carpenter fell into

confusion. It can be discriminated from *C. undatella* by its coarser and more distant sculpture and the fact that in the adult the ribs of the middle of the lower half of the disk generally are thickened and flattened, showing a polished surface which nearly covers the interspaces. *V. californiana* Conrad, 1837; *V. californiensis* Broderip, 1835; *V. leucodon* Sowerby, 1835; *V. simillima* Carpenter, 1857, not of Sowerby, 1853; and *V. crassa* (Sloat, MS. in) Carpenter, 1864, are synonymous.

CHIONE (CHIONE) COMPTA Broderip, 1835.

Peru and northward to the Gulf of California in 21 to 26 fathoms.

This species has the concentric ribs few and very distant, is relatively flatter than *C. succincta* of the same size, and the pallial line is hardly sinuated and is unusually distant from the ventral margin of the valves. *Venus californica* Carpenter, 1856 and 1872, is this species, the name arising from an error of the types.

CHIONE (CHIONE) SUBROSTRATA Lamarck, 1818.

Mazatlan, Central American coast, and south to Payta, Peru. Also on the Atlantic coast.

This is *Venus crenifera* Sowerby, 1835; *V. portesiana* Orbigny, 1846; *V. beaui* Recluz, 1852; and probably *V. lunularis* Philippi, 1844. Carpenter, in 1863, identified *V. sugillata* Reeve with this species.

CHIONE (CHIONE) PURPURISSATA Dall, 1902.

Cape St. Lucas and the Gulf of California.

This beautiful species, with the interior of the disk rosepurple, was figured by Reeve[a] as a variety of *Venus crenulata* of the West Indies (by which *Chione pubera* Valenciennes is meant), and was named variety *lilacina* by Carpenter, 1864; but it is not *Chione lilacina* Gray, 1838, and so a new name is proposed for it. It is a rounder shell than *C. pubera*, with less prominent lamellation, especially on the posterior slope, which, in this species, is often wholly destitute of lamellae.

CHIONE (CHIONE) PULICARIA Broderip, 1835.

Gulf of California from its head to Guaymas and south to Chiriqui, West Colombia.

This is *Venus cingulata* Reeve, 1863, not of Lamarck, 1818; and *V. pinacatensis* (Sloat, MS. in) Carpenter, 1864. This species is the Pacific analogue of *C. intapurpurea* Conrad, of the Atlantic fauna, but a more elongated and pointed species.

It is *Venus pfefferi* Dunker, MS., according to Römer, 1867.

[a] Conch. Iconica, *Venus*, pl. XIII, fig. 46, 1863.

CHIONE (CHIONE) AMATHUSIA Philippi, 1844.

Gulf of California to Panama, in 7 to 24 fathoms.

Perfectly distinct from *C. gnidia*, with which it has been confused. *Venus encausta* is said by Sowerby to be a synonym, but no author is cited for it in the *Thesaurus*. It is smaller, more pyriform, and with much less prominent lamellation and finer radial sculpture.

CHIONE (CHIONE) GNIDIA Broderip and Sowerby, 1829.

Cerros Island, on the Pacific shore of Lower California, the Gulf of California, and south to Panama Bay, in 7 to 24 fathoms.

This is the largest and finest of the genus, reaching a length of 85 mm. It is white inside and, when fully adult, has the crenulated inner margin of the valves brown. I suspect *V. ornatissima* Broderip, 1835, to be founded on a particularly oval and lamellose young shell of this species.

CHIONE (CHIONE) EFFEMINATA Stearns, 1890.

"Panama Bay;" Thomas Bridges.

A small, compressed, closely reticulate species, grayish white externally, wholly purple internally, with the hinge and profile of an *Anomalocardia*, to which group I am tempted to refer it, though it, in some respects, seems closer to *Chione*. It has a very Indo-Pacific aspect.

CHIONE (CHIONE) DARWINI Dunker, 1857.

Mazatlan to Panama (Römer).

Regarded as a variety of *C. gnidia* by Carpenter, 1857, and as a variety of *C. amathusia* by Deshayes, 1853. It is stated to differ by having the ventral faces of the concentric lamellæ polished purple brown, as well as the lunule and escutcheon. I have seen no specimens which agree with the descriptions, and regard it as a doubtfully distinct form and perhaps a variety of *C. subrostrata*. It was described from Dunker's manuscript by Römer, 1857.

CHIONE (LIROPHORA) OBLITERATA Dall, 1902.

Humboldt Bay, Gulf of Panama; Arthur Schott.

This is the analogue of *C. latilirata* Conrad of the Atlantic fauna, from which it differs in having the concentric ribs less elevated and more irregular and the shell more rostrate. The coloration is about the same.

CHIONE (LIROPHORA) KELLETTII Hinds, 1844.

Gulf of California and south to the Bay of Panama in 8 to 50 fathoms.

A remarkable species, in which the concentric ribs (of a yellow-brown color) are smoothly coalescent on the disk, but are expanded as

prominent white leaflets at each end of the shell. The nepionic young are white, smooth, globular, with one or two sharp distant concentric lamellæ.

CHIONE (LIROPHORA) MARIÆ Orbigny, 1847.

Gulf of California and south to Guayaquil, in 12 to 50 fathoms.

This analogue of *Chione paphia* has narrow, high, and recurved concentric ribs, with fine radial wrinkles, obsolete in the interspaces, except near the beaks. The closeness and number of the ribs in the young is quite variable. It is quite distinct from *C. paphia*. It is the *Venus cypria* Sowerby, 1835, and *Chione cypria* Deshayes, 1853, but not *Venus cypria* Brocchi, 1814, or Risso, 1826. *Venus discrepans* Sowerby, 1853, should be compared with this species.

CHIONE (LIROPHORA) SCHOTTII Dall, 1902.

Humboldt Bay, Gulf of Panama; Arthur Schott.

Small, white, with close, flat, subconcentric, low ridges, abruptly attenuated or duplex on the posterior dorsal area; the valves rounded below with high beaks. The sculpture, on a small scale, recalls that of *Amiantis callosa*.

CHIONE (TIMOCLEA) ASPERRIMA Sowerby, 1835.

Gulf of California, at La Paz, and southward to Payta, Peru.

This shell is easily confused with *Protothaca grata* Say, from which it may be distinguished by its more rasplike surface, larger lunule, extremely long anterior cardinal, and more cuneate outline. It is yellowish or olive, sometimes maculated with brown. *Venus intersecta* Sowerby, 1852, is said to be a synonym though the figures look more like *C. pectorina*. The dubious Lamarckian name of *cardioides* has also been assigned to this species, but this depends chiefly on guesswork. The *V. pectunculoides* Valenciennes, 1839, is said to be identical.

CHIONE (TIMOCLEA) TUMIDA Sowerby, 1852.

Panama and West Colombia.

This is distinguished from the preceding by its tumid, squarish form, finer and more delicate sculpture, and longer hinge line. It is not the variety *tumida* cited by Carpenter for a Californian *Protothaca*.

CHIONE (TIMOCLEA) COLUMBIENSIS Sowerby, 1835.

Mazatlan to Payta, Peru.

This is remarkable for the strength of its flat ribs and rounded, *Cardium*-like outline. It is not the *Venus dombeyi* or *dombeii* of Lamarck, as was supposed by Deshayes, but it shares with that species the peculiarity of having the concentric sculpture absent over the middle part of the disk. It is generally of a dark mottled brownish color externally, and white or with a faint purple flush internally.

CHIONE (TIMOCLEA) PERTINCTA Dall, 1902.

Galapagos Islands.

This is a remarkable shell, white, with brown flames on the posterior dorsal slope, and a brown lunule; the sculpture almost exclusively of distant narrow sulci, which tend to fail at an anterior space in front of the vertical of the beaks. The inner margin is crenulate and white, and except the cavity under the beaks, the interior is usually of a very dark rich purple. Worn specimens were referred to *Paphia grata* Say, by Stearns in his list of Galapagos shells, in 1893.

ANOMALOCARDIA SUBRUGOSA Sowerby, 1834.

Margarita Island, Lower California, the Gulf of California, and southward to Valparaiso.

This well-known and characteristic form was named *Cytherea subsulcata* by Menke according to Philippi, 1844; and *Venus* (*Triquetra*) *triradiata* Anton, 1839.

ANOMALOCARDIA SUBIMBRICATA Sowerby, 1835.

Cape St. Lucas, the Gulf of California, and south to Panama Bay.

Venus bilineata Reeve, 1863, may perhaps be synonymous. *Chione tumens* Verrill, 1870, is one of the numerous mutations.

VENUS KENNICOTTII Dall, 1871.

Neah Bay, Washington, to Little River, Mendocino County, California.

Shell of a yellowish-white color and apparently very rare. It is finely closely lamellose over the whole surface and the rugose area of the hinge is much smaller than in *V. mercenaria*. The corrugated space is more narrow and delicate than in the Atlantic species, but this area is still further diminished in the Japanese *V. stimpsoni* Gould, the only exotic species of the group, first named *V. orientalis* in MS. according to Carpenter, 1856.

VENUS APODEMA Dall, 1902.

Humboldt Bay, Gulf of Panama, Arthur Schott.

A rounded species with low, wide concentric riblets, radially striated on the umbones and with very feeble crenulation of the inner margins.

MARCIA KENNERLEYI (Carpenter MS.) Reeve, 1863.

Kadiak Island and Port Etches, Prince William Sound, Alaska; and southward to Monterey, California, in 8 to 18 fathoms.

The shell is grayish white, with low, coarse, somewhat irregular concentric ribbing. It has been confused by Gabb with *Venus perlaminosa* Conrad, 1855, a miocene fossil, and another form afterwards called *pertenuis* by Gabb, 1869.

MARCIA RUFA Lamarck, 1818.

Chile, northward to the Gulf of Panama.

This is the *Venus opaca* of Sowerby, 1835, and has the external features (but not the hinge) of *Saxidomus;* there is also a circumscribed lunule. *Venus lithoida* Jonas, 1844, is synonymous and *V. expallescens* Philippi, 1844, is based on the young shell. The striation on the anterior half of the shell varies and may be obsolete. On a smooth specimen Deshayes, in 1853, founded his *Saxidomus squalidus*, a name which has been wrongly applied to a northwest coast species. Jonas stated in his diagnosis that there is no lunule, but his own drawing, given by Philippi, shows it to be present; and in separating Philippi's figure from Jonas's name Deshayes overlooked the fact that both were derived from Jonas himself. He also duplicates the species by entering it as *Chione rufa* in his list.

MARCIA (VENERELLA) SUBDIAPHANA Carpenter, 1865.

Unimak Pass, Alaska, east and south to the Santa Barbara Channel, in 10 to 120 fathoms.

Thin, white with olive gray periostracum; variable in form from trigonal to long ovate. Described by Carpenter under the name of *Clementia*. It reaches a length of 63 mm. and is found in the Pliocene of California.

PAPHIA (PROTOTHACA) GRATA Say, 1831.

From Turtle Bay, on the Pacific shore of Lower California, to Cape St. Lucas, the Gulf of California, and southward to Panama Bay.

This beautiful species revels in color variations, many of which have received names. Thus it is the *Venus discors*, *tricolor*, *fuscolineata*, and *histrionica* of Sowerby in 1835, and was called *straminea* (as of Conrad) by him in 1852. Deshayes referred it to *Chione* and described a *Tapes grata* from the Philippines in 1853, which is a wholly different shell, named *T. deshayesii* by Carpenter in 1864. It was called *Venus muscaria* by Reeve in 1863, but it is not the *Cytherea muscaria* of Lamarck in 1818. *V. pectunculoides* Valenciennes, 1846, may be synonymous. The escutcheon varies from distinct to obsolete, and the species can not be divided on this character. *Tapes fluctuosa* Sowerby, 1853 not of Gould, 1841, is probably a young shell of this species.

PAPHIA (PROTOTHACA STAMINEA Conrad, 1837.

North Japan, Sakhalin, Kamchatka, Bering Island, the Aleutians, and the west coast of America, from the peninsula of Alaska southward to Cape St. Lucas and Socorro Island.

I have seen no specimens of this species from the Pribilof Islands or from south of Socorro Island. The specimens from Panama

referred to this species should be united with *P. thaca* Molina, which occurs there abundantly. It is one of the common market clams of California, and is even canned for export.

There are a number of recognizable varieties which will be noted. The typical form is elegantly radially ribbed with fine even riblets, the concentric sculpture inconspicuous, the color yellowish white with pale purplish brown maculations. This variety has been collected at Crescent City, California, and occurs from thence southward to the limits of the range, though the species is not abundant anywhere south of Monterey, California.

Conrad's original specimens came from Santa Barbara and San Diego. Absolute synonyms of the typical form are *Venus mundulus* Reeve, 1863; *Chione straminea* Deshayes, 1853, but not of Sowerby, 1852; and *Venus dispar* and *ampliata* (Gould MS.) in Carpenter, 1857.

PAPHIA STAMINEA var. PETITI Deshayes, 1839.

This is the most common form of the species, the form especially abundant north of the Columbia River. It is larger than the southern variety, of a yellowish, chalky white, or dull gray color, without maculations; and the separation of the sculpture into areas is often well marked.

It was described as *Venerupis* and afterward referred to *Saxidomus* by Deshayes. It is *Venus rigida* Gould, 1850 (not of Dillwyn, 1817), in major part, and *Tapes diversa* Sowerby, 1852.

PAPHIA STAMINEA var. LACINIATA Carpenter, 1864.

Monterey, California, to San Diego.

This extremely elegant variety is evenly reticulated by concentric and radial sculpture, and derives its individuality from the development of small prickles or spines at each intersection. When these spines are worn off it can not be separated from the variety *petiti*, but with them it is unmistakable.

PAPHIA STAMINEA var. RUDERATA Deshayes, 1853.

This form, which is found chiefly in the north, is characterized by the turgidity and prominence of the concentric sculpture, which becomes more conspicuous than the radial ribs. Occasionally the shells are delicate and elegant, but usually specimens of this variety are rude and irregular, coarse and unattractive. It was referred to *Chione* by Deshayes, and sometimes it looks not unlike *Marcia kennerleyi*, which, however, has no radial sculpture.

PAPHIA STAMINEA var. ORBELLA Carpenter, 1864.

This variety comprises those specimens which have nestled in the borings of the large Pholads of the coast, especially at Monterey, and have been obliged to grow into an abnormally swollen and tumid

shape. They are usually chalky and of a gray tint. A variety *tumida* (but not *Tapes tumida* Sowerby, 1853) has been proposed by Carpenter, but it does not differ from *orbella* sufficiently to name, though it was renamed *Chione conradi* by Römer in 1867.

PAPHIA STAMINEA var. SULCULOSA Dall, 1902.

San Ignacio lagoon, west shore of Lower California.

This differs from the ordinary forms of the species in having the concentric sculpture obsolete, the ribs fewer and stronger, and behind the middle of the shell separated by equal or even wider unsculptured channels or interspaces. The color is pure white, and the only specimens of this variety I have seen were collected by Henry Hemphill.

PAPHIA (PROTOTHACA) THACA Molina, 1782.

Bay of Panama to Valparaiso, Chile.

When well developed this form is very striking on account of the discrepant sculpture on the different parts of the disk, a feature which exists, more or less distinctly, in all the species of this group. The young are sometimes prettily painted with purple brown. It is a notable species for economic purposes in Chile, where it is largely used for food, and called *taca*. It was first described by Molina as *Chama thaca* and referred to *Venus* by Gmelin. It is the *V. dombeii* Lamarck, 1818; *V. chilensis* Sowerby, 1835; *V. ignobilis* Philippi, 1844; but not *Venus columbiensis* Sowerby, as stated by Deshayes in 1853.

PAPHIA (CALLITHACA) TENERRIMA Carpenter, 1856.

Victoria, British Columbia, and south to San Quentin Bay, Lower California.

This magnificent shell is markedly distinct in its characters from, and much larger than any of the other west coast species of the genus. It seems to be rather rare. When Dr. Gould described his *Venus rigida* (not *Venus rigida* Dillwyn, 1817) he included representatives of two species. One of these was *Paphia staminea* Conrad, and the other the present species, which was discriminated by Dr. Carpenter.

LIOCYMA BECKII Dall, 1870.

Plover Bay, Eastern Siberia, near Bering Strait, and southward to Unalaska, eastward to Kadiak and Prince William Sound, in 6 to 60 fathoms. Also North Japan.

Shell subtrigonal, inflated, with yellow or greenish periostracum, and irregular concentric sulci. Length of largest individual, 18.0; diameter, 8.5 mm.

LIOCYMA VIRIDIS Dall, 1871.

Point Barrow, Arctic Ocean, south through Bering Strait and Sea to the Okhotsk Sea, the Aleutian Islands, and eastward to Kadiak Island, Alaska, in 4 to 70 fathoms. Also North Japan.

Shell oval, quite inequilateral, when fresh of an olive-green or rich olive-brown color, bleaching on the beach to cream color, with regular, rather distant concentric sulci; subcompressed, sometime almost rostrate behind. Maximum length, 38.0; diameter, 13.5 mm.

The young are very like the adult *L. fluctuosa* Gould, of the boreal Atlantic, but have a deeper pallial sinus.

LIOCYMA SCAMMONI Dall, 1871.

Port Simpson, British Columbia, Scammon.

Brown, dark, solid, with heavy hinge and strong, prominent ligament. The umbones are more central and the pallial sinus more shallow than in any other species. Maximum length, 24.0; diameter, 11.5 mm.

VENERUPIS LAMELLIFERA Conrad, 1837.

Farallones Islands, off San Francisco Bay, and south to Lower California.

This very irregular species has obsolete radial and often very strong, distant, concentric lamellæ, though under favorable conditions, especially in adolescent specimens, the lamellæ may be thin and sharp. The young are brightly colored, the adults dull and earthy, though toward the southern extreme of its range the shell becomes more porcellanous. It was described as *Venus lamellifera* by Conrad, and *Petricola cordieri* Deshayes, 1839, is synonymous. It has been generally known as *Rupellaria lamellifera*, as determined by Carpenter.

VENERUPIS FOLIACEA Deshayes, 1853.

Cape St. Lucas, the Gulf of California, and southward to Acapulco and the Bay of Panama.

A short and foliaceous species, more or less stained with purple. *Tapes squamosa* Carpenter, 1857, from Mazatlan, is the nepionic young of this species. *Venerupis paupercula* Deshayes, 1853, if really from Mazatlan, is perhaps identical, and *Venus troglodytes* Mörch, 1861, is certainly synonymous.

VENERUPIS OBLONGA Sowerby, 1834.

Bay of Panama to Payta, Peru.

Venerupis fimbriata Sowerby, 1853, is probably synonymous; *V. elliptica* and *V. solida* Sowerby, 1834, belong in the genus *Petricola*, where Sowerby originally placed them, and not in *Venerupis*, to which they were referred by Deshayes. The relations of *V. oblonga* to *V. foliacea* are in need of elucidation.

PSEPHIDIA LORDI Baird, 1863.

Port Etches, Prince William Sound, Alaska, and southward to Catalina Island, California, in 4 to 15 fathoms.

White, pale green, or straw color, quite trigonal and plump, often containing the nepionic young.

PSEPHIDIA OVALIS Dall, 1902.

Pribilof Islands, Bering Sea, the eastern Aleutians, and the main coast eastward and southward to San Diego, California, in 3 to 20 fathoms.

Yellowish white, oval, subcompressed, and attaining a larger size than *P. lordi*.

"*Psephis tellimyalis*" Carpenter, 1864, is the nepionic young of *Petricola*, as determined from the type specimens. The name has often been mistakenly applied to *P. ovalis*, and the latter has also been mistaken for *P. lordi* in the absence of figures or typically named specimens. A species of *Psephidia* quite near to *P. ovalis* occurs in the Pleistocene terraces of Volcano Bay, Yesso, Japan, where specimens were collected by Pumpelly.

GEMMA GEMMA Totten, 1834.

Shores of San Francisco Bay, introduced with "seed" oysters from Chesapeake Bay about 1899.

The form obtained is the variety *purpurea* Lea. For synonymy, etc., see Atlantic list. It is not yet certain that the species is established on the Pacific coast.

NOTES ON AND DESCRIPTIONS OF WEST COAST AMERICAN SPECIES

The available material for the west coast of South America is so meager that no attempt has been made to include species which do not reach the southern limit of the Panamic fauna near Payta, Peru.

CLEMENTIA SOLIDA, new species.

Plate XIV, fig. 4.

Shell large and solid for the genus, with an obscure ridge extending from near the beaks to the posterior end of the basal margin; umbonal region concentrically undulated and the whole shell concentrically, somewhat irregularly, strongly striated; beaks prominent, small; lunular region deeply impressed, though there is no defined lunule or escutcheon; ligament short, on strong nymphs; three entire cardinal teeth in each valve; inner margins smooth; adductor scars large; pallial sinus narrow, long, obliquely ascending, rather blunt in front. Height, 63; length, 79; diameter, 34 mm.

A single valve of this rather remarkable shell was brought to the United States National Museum from Topolobampo, Mexico, by Professor Daniels. Cat. No. 126352, U.S.N.M.

CALLOCARDIA CATHARIA, new species.

Plate XIV, fig. 3.

Shell large, white, somewhat earthy, with a pale olive periostracum; beaks high, prominent, strongly anteriorly directed over a large cordate lunule delimited by an impressed line; extremities slightly produced, base arcuate; anterior slope short and straight, posterior arched, a shallow sulcus cutting off a narrow raised area on each side of the ligament; surface more or less shining, finely, closely, sharply, concentrically sulcate; the middle of the shell in the early stages smooth or with the sulcations feeble, but in the adult they are uniformly continuous; interior white with a faint salmon flush in the cavity of the beaks; pallial sinus very near the margin, exceptionally wide and shallow, rounded in front; the muscular impressions quite small; hinge well developed, normal. Length, 52; height, 43; diameter, 30 mm.

Bay of Panama, in 30 fathoms, mud, at station 2799, United States Fish Commission steamer *Albatross*. Cat. No. 96368, U.S.N.M.

The species appears to be abundant and always pure white externally. The pallial sinus seems to vary in form; in the younger shells it is relatively narrower and more angular, in the adults shorter and more rounded. These differences are rather surprising, as the form of the pallial sinus in most bivalves is fairly constant.

PITARIA TOMEANA, new species.

Plate XV, fig. 2.

Shell small, yellowish white, rather earthy in texture, smooth except for very fine concentric wrinkles; beaks small, pointed; lunule small, defined by a feebly impressed line; periostracum thin, papyracous; interior white, margins entire, the area within the pallial line earthy, the pallial sinus linguiform, short; hinge normal, solid, the anterior lateral subconical. Length, 23.5; height, 20; diameter, 12 mm.

Brought up with mud on the anchor at Tomé, Chile, by the United States Fish Commission steamer *Albatross*. Cat. No. 109220, U.S.N.M.

This is an inconspicuous little species, which may in some instances develop color markings, though the specimens obtained do not.

PITARIA (LAMELLICONCHA) CALLICOMATA, new species.

Plate XVI, fig. 8.

Shell white, rather earthy, moderately convex, elongate ovate; covered with prominent sharp, thin, concentric lamellæ, every third or fourth of which is higher than the others; near the anterior end the

lamellation is somewhat more prominent, as usually the case in this group; there are also some fine concentric wrinkles; lunule small, lanceolate, nearly smooth, impressed; ligament defended on each side by a narrow raised rib; there is no radial sculpture; interior pure white; pallial sinus long, linguiform, upper boundary of it nearly horizontal; internal margins smooth, hinge normal, anterior lateral strong. Length, 47; height, 36; diameter, 22 mm.

Bay of Panama, in 14 fathoms, mud, at station 2801, by the United States Fish Commission steamer *Albatross*. Cat. No. 96388, U.S.N.M.

CYTHEREA (VENTRICOLA) FORDI Yates.

Plate XV, fig. 7.

As the original figures in the Bulletin of the Santa Barbara Society of Natural History are accessible to few students, I have added a figure of a well-grown valve from the collection of the United States National Museum, dredged by me off the north side of Catalina Island in 16 fathoms. Cat. No. 120704, U.S.N.M.

CYTHEREA (VENTRICOLA) MAGDALENÆ, new species.

Plate XV, fig. 6.

Shell thin, inflated, suborbicular, inequilateral, the beaks near the anterior fourth of the length; color yellowish, with radial series of pale brown painting; lunule cordate, striate, flattish, pale brown; escutcheon not defined; sculpture of primary distant and secondary adjacent concentric lamellæ which are pedicillate, their expanded summits coalescent and microscopically radially, closely striate; interior white or yellowish; inner margins minutely crenate; pallial sinus small, angular; hinge strong, anterior lateral distinct in the young, anterior right and posterior left cardinals thin, entire, the others thicker and sulcate or bifid. Length, 42 (to 48); height, 38; diameter, 26 mm.

Dredged by the United States Fish Commission steamer *Albatross* off Magdalena Bay on the west shore of Lower California, at station 2989, in 36 fathoms. Cat. No. 109214, U.S.N.M.

CYTHEREA (FOVEOLATA VAR?) LEPIDOGLYPTA Dall.

Plate XV, figs. 4, 5.

Shell suborbicular, moderately convex, yellowish white, profusely concentrically lamellose; beaks prominent, anteriorly directed; lamellæ on the beaks somewhat alternated, three or four secondary lamellæ appearing between each pair of primary slightly higher ones, but over the greater part of the disk they are uniform and similar, with slightly wavy edges and the ventral face of each lamella very finely closely transversely striated, the bottom of the channels between the ribs

without sculpture except lines of growth; lunule large, cordate, circumscribed by an incised line, lamellose, the apposited edges slightly pouting; escutcheon bordered by a sharp keel in the left and a rounded ridge in the right valve; wider and smooth in the left, narrower and more or less lamellose in the right valve, the latter slightly overlapping behind; ligament sunken but not covered; the concentric sculpture slightly more prominent distally; interior white, the margins finely crenulate; the pallial sinus short, wide, angular, reaching forward only to the vertical of the posterior end of the ligament; hinge strong, the posterior pair of right cardinals and the middle left one subsulcate; anterior lateral distinct. Length, 41; height, 36; diameter, 23 mm.

Purchased with a lot of west coast beach shells at Acapulco, Mexico, in 1868, by W. H. Dall. Cat. No. 103286, U.S.N.M.

This looks almost exactly like a young quahog, externally, and the *Cytherea* hinge is a surprise. Only one specimen has been examined. It agrees with dealer's shells which come to me named *foveolata* Sowerby, a species which so far seems positively located only in the Cape Verde Islands.

CYCLINELLA SINGLEYI, new species.

Plate XV, fig. 3.

Shell suborbicular, white, shining, but not polished, covered with fine, sharp concentric striation and marked with obscure obsolete radial lineation; valves convex, slightly flattened on the posterior dorsal slope; beaks small, pointed, slightly anteriorly twisted; lunule lanceolate, defined by an impressed line; ligament long, strong, deeply inset; interior white, earthy, with entire margins and a deep, angular pallial sinus, pointing toward the umbo of the shell. Length, 39; height, 38; diameter, 23 mm.

Collected near the delta of the Yaqui River, West Mexico, by J. A. Singley. Cat. No. 108817, U.S.N.M.

This is a more inflated, more sharply sculptured, and more shining species than any of the others.

CHIONE (LIROPHORA) SCHOTTII, new species.

Plate XVI, fig. 7.

Shell small, white, rounded-trigonal, with high, pointed, slightly recurved beaks; lunule long, lanceolate, narrow; escutcheon, limited by an inconspicuous keel, nearly smooth; sculpture of close-set subconcentric, flattened ribs, separated only by much narrower sulci, and not always in harmony with the incremental lines; these ribs are abruptly attenuated or bifurcate on the posterior dorsal area; there is no trace of any radial sculpture; interior white; pallial sinus small and rather

open; internal margins crenate, hinge normal, teeth entire. Length, 14; height, 13; diameter, 8 mm.

Collected by Arthur Schott, at Humboldt Bay, Gulf of Panama. Cat. No. 6226, U.S.N.M.

These specimens are small, and very likely not of full size; they may also be somewhat bleached, but they certainly can not be identified with any of the other species of the coast.

CHIONE (LIROPHORA) OBLITERATA, new species.

Plate XVI, fig. 2.

Shell solid and heavy, subtrigonal, with very posterior beaks; of a pale yellow or yellow-brown color, with faint purplish radial flames or flecks; lunule short cordate, nearly smooth; escutcheon elongate, excavated, smooth; beaks small, anteriorly directed; surface smooth or obsoletely radially striated, sculptured with heavy tumid concentric waves which in the adult become somewhat irregular and sometimes coalescent on the disk, more or less angular and bifid on the posterior dorsal slope; interior yellowish with a flush of purple near the hinge; hinge normal; pallial sinus very short and small, angular, inner margins minutely crenate. Length, 24; height, 18; diameter, 14 mm.

Humboldt Bay, Gulf of Panama, two left valves, Cat. No. 11821 and 6227 U.S.N.M.

This is the analogue of the Atlantic *C. latilirata* Conrad, but differs by well-marked characters from that as well as from the species of the *paphia* or *mariæ* type which have regular ribs. It reaches a length of some 30 mm.

CHIONE (TIMOCLEA) PERTINCTA, new species.

Plate XVI, fig. 9.

Shell solid, ovate or cuneate, white externally, with a flush of pink near the umbones, the small lanceolate lunule dark brown, the posterior dorsal slope with wavy red-brown lines irregularly longitudinal. There is a very narrow striated escutcheon; beaks low, at the anterior third; surface with feeble concentric sculpture not rising into lamellæ; radial sculpture conspicuous, of sulci with the anterior slope steep and short, the other covering the whole interspace to the next posterior sulcus; near the lunule the sulci are close and well marked, then for a short space they are almost absent, after which they extend with rather wide interspaces to the posterior end of the shell; these characters of the sculpture may not be invariable, but in the two best preserved valves are similar; interior with the hinge strong, the middle left cardinal bifid, the pallial sinus short, linguiform, the cavity of the valves except near the beaks and margin stained with very dark purple, the inner margins finely crenulate. Length, 37; height, 28; diameter, 19 mm.

Indefatigable Island of the Galapagos group; a number of worn valves. Cat. No. 102457, U.S.N.M.

The young shells appear to be oval, the only well-preserved adult valve, which is figured, is distinctly cuneate. In general the species is more elongate than the other species of the coast and the sculpture is quite unlike any of the others, the nearest being *C. columbiensis*, which has channeled and regular sulci between flat ribs.

VENUS APODEMA, new species.

Plate XV, fig. 8.

Shell suborbicular, convex, white, concentrically ribbed with narrow, solid, hardly elevated riblets separated by narrower sulci; beaks very anterior, incurved, low, finely radially striated; anterior slope short with a small cordate lunule; posterior slope arcuate, with an elongated area bounded by a rounded ridge which does not interrupt the sculpture; interior white, the margins with fine obscure crenulation; pallial line with a short angular sinus; hinge normal, the corrugated area small and narrow. Height, 43; length, 47; diameter, 28 mm.

Humboldt Bay, Gulf of Panama, Arthur Schott. Cat. No. 6243, U.S.N.M.

A single somewhat worn valve was collected by Schott with numerous other beach shells, which he presented to the National Museum nearly fifty years ago. It has been named and figured, because of the interest attaching to the discovery of this genus in those waters, and because it seems certain that it does not agree with any already known species. It is very probable that the sculpture was considerably sharper when the shell was fresh and the concentric sculpture unworn, but it is evident that the latter never was sharply lamellar as in the Atlantic species.

MARCIA KENNERLEYI Reeve apud Carpenter.

Plate XIV, fig. 1.

A figure of a specimen obtained alive in the harbor at Sitka, Alaska, is included. Cat. No. 23441, U.S.N.M.

A worn valve of this species was collected by me at Carmel Bay, near Monterey, California, in 1866.

PAPHIA (PROTOTHACA) STAMINEA var. SULCULOSA, new species.

Plate XIV, fig. 2.

San Ignacio lagoon, Lower California; Henry Hemphill. Cat. No. 105421, U.S.N.M.

This form, through its modified sculpture, is so different from the ordinary type that it seemed best to figure it. Only with a large series can its relations to the type be fully appreciated.

LIOCYMA BECKII Dall.

Plate XVI, fig. 3.

Liocyma beckii DALL, Proc. Boston Soc. Nat. History, XIII, 1870, p. 257; Am. Journ. Conch., VII, 1871, p. 145, pl. XIV, fig. 7.

Plover Bay, eastern Siberia, at the western entrance of Bering Strait. Cat. No. 163110, U.S.N.M.

LIOCYMA VIRIDIS Dall.

Plate XV, fig. 1.

Liocyma viridis DALL, Am. Journ. Conch., VII, 1871, p. 146, pl. XIV, fig. 8.

Kyska Harbor, Great Kyska Island, in 8 fathoms, sand; W. H. Dall. Cat. No. 160904, U.S.N.M.

LIOCYMA SCAMMONI Dall.

Plate XVI, fig. 1.

Liocyma scammoni DALL, Am. Journ. Conch., 1871, VII, p. 145, pl. XIV, fig. 9.

Port Simpson, British Columbia; Capt. C. M. Scammon. Cat. No. 163121, U.S.N.M.

PSEPHIDIA LORDI Baird.

Plate XVI, figs. 5, 6.

Chione lordi BAIRD, Proc. Zool. Soc., 1863, p. 69, pl. II, fig. 10.
Psephis lordi CARPENTER, Proc. Acad. Nat. Sci. Phila. for 1865, p. 57.

Lituya Bay, Alaska, in 8 fathoms, sand; W. H. Dall. Cat. No. 163071, U.S.N.M.

The specimen figured is perhaps more trigonal than usual, others are slightly more produced behind.

PSEPHIDIA OVALIS, new species.

Plate XVI, fig. 4.

Shell small, white, polished, oval, subcompressed; surface with obsolete concentric threads near the anterior base, but over most of the disk smooth; beaks small and very low, at about the anterior third of the length; lunule elongated, extremely narrow, nearly as long as the anterior dorsal slope; escutcheon linear or none; interior white, the pallial sinus moderate, pointed; internal margin delicately striated; hinge well developed, like that of *P. lordi*, with three entire cardinals and no anterior lateral tooth. Length, 8.5; height, 6.5; diameter, 3.0 mm.

North side Catalina Island, California, in 16 fathoms gravel and sand: W. H. Dall. Cat. No. 163089, U.S.N.M.

The species is viviparous: some of those taken having as many as thirty young shells in the anal chamber. It is always distinguishable from *Psephis tantilla* (Gould) Carpenter by its hinge and oval form, and from *P. lordi* by its oval outline, compressed valves, and thinner shell. *Psephis tellimyalis* of Carpenter, 1864, is the nepionic young of a species of *Petricola*, and his *Psephis salmonea* bears the same relation to some other bivalve, apparently a species of *Tivela*, not *T. stultorum*.

NOTES.

Dosinia angulosa Philippi, through having the name of the Chinese province of Chi-li, latinized into *chiliense* by Deshayes, has been erroneously supposed to extend its range to South America.

The National Museum contains a valve of *Dosinia prostrata* said to have been dredged in the Gulf of California, but as the collector had also visited and collected on the coasts of China and Japan, I suspect a mixture of labels to be responsible for an obvious error. *Clementia gracillima* Carpenter, 1857, from Mazatlan, is an unidentifiable nepionic shell, less than a tenth of an inch in length.

The genus *Circe* does not occur on the west coast of America; even *Gouldia*, which might be expected, is unknown. Two shells described as *Circe margarita* and *C. subtrigona* by Carpenter, in 1857, from Mazatlan, are nepionic shells, which are so juvenile in their characters as to be impossible of identification at present. We may assume it to be certain that they do not belong to the genus *Circe*. *Circe nummulina* Lamarck, 1818, was listed from Central America by Sir E. Belcher, but his localities were notoriously not dependable. *Cytherea petechialis* Lamarck, 1818, is listed by Carpenter from Mazatlan, having been found among the Reigen shells, but it is certainly exotic, none having appeared from there for half a century. *Saxidomus brevisiphonatus* Carpenter, 1865 (and *Darina declivis* of the same date), have never been collected since they were described from the Vancouver region. I believe them to be exotics which were accidentally mixed with West Coast shells. Specimens supposed to be the *Saxidomus*, sent by West Coast collectors, have invariably proved to be mutations of *S. giganteus*. The name *Saxidomus squalidus*, given to a South American shell, probably a *Marcia*, has been frequently applied to the *S. giganteus*, following an error of Carpenter.

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EXPLANATION OF THE PLATES.

PLATE XII.

EAST AMERICAN VENERIDÆ.

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2. *Tivela nasuta* Dall. Cat. No. 153377, U.S.N.M.; length, 33.0 mm.; Santa Marta, Colombia; p. 380.

3. *Tivela braziliana* Dall. Cat. No. 125468, U.S.N.M.; length, 40 mm.; Brazil; p. 381.

4. *Callocardia* (*Agriopoma*) *zonata* Dall. Cat. No. 92015, U.S.N.M.; length, 22.0 mm.; North Carolina; p. 381.

5. *Cytherea* (*Ventricola*) *strigillina* Dall. Cat. No. 95608, U.S.N.M.; length, 38.0 mm.; Key West, Florida; p. 381.

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Plate XIII.

EAST AMERICAN VENERIDÆ.

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7. *Dosinia* (*Dosinidia*) *elegans* Conrad, interior view. Cat. No. 6120, U.S.N.M.; length, 68.0 mm.; Texas; p. 379.

Plate XIV.

WEST AMERICAN VENERIDÆ.

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WEST AMERICAN VENERIDÆ.

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3. *Cyclinella singleyi* Dall. Cat. No. 168817, U.S.N.M.; length, 39.0 mm.; Yaqui River delta, Gulf of California; p. 404.

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7. *Cytherea* (*Ventricola*) *fordi* Yates. Cat. No. 120704, U.S.N.M.; length, 47.0 mm.; Catalina Island, California; p. 403.

8. *Venus apodema* Dall. Cat. No. 6243, U.S.N.M.; length, 47.0 mm.; exterior view of a somewhat worn specimen from Humboldt Bay, Gulf of Panama; p. 406.

Plate XVI.

WEST AMERICAN VENERIDÆ.

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3. *Liocyma beckii* Dall. Cat. No. 163110, U.S.N.M.; length, 14.0 mm.; Plover Bay, near Bering Strait, Eastern Siberia; p. 407.

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7. *Chione* (*Lirophora?*) *schottii* Dall. Cat. No. 6226, U.S.N.M.; length, 14.0 mm.; Humboldt Bay, Gulf of Panama; p. 404.

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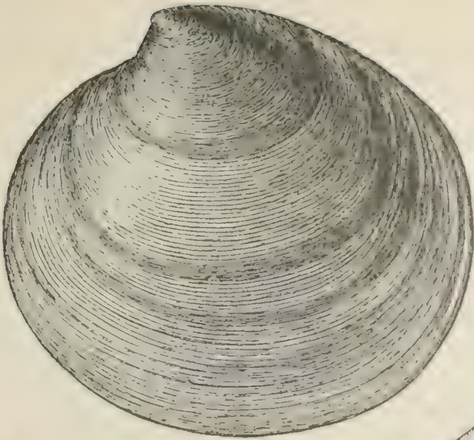

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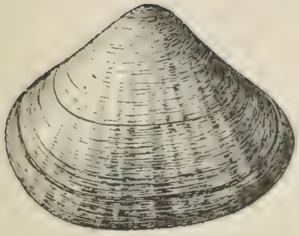

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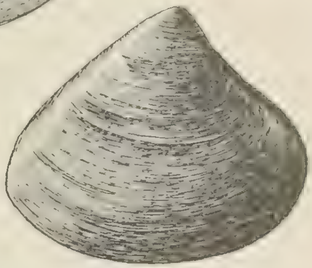

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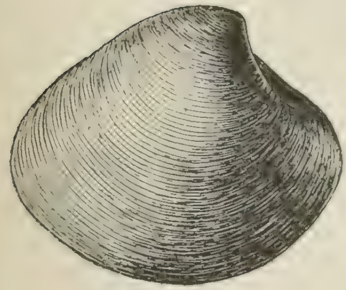

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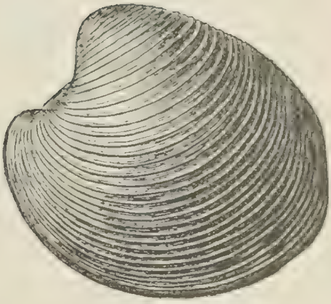

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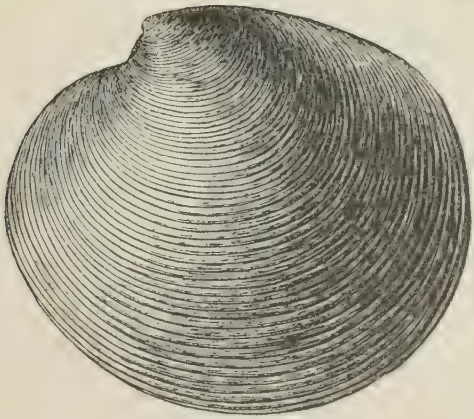

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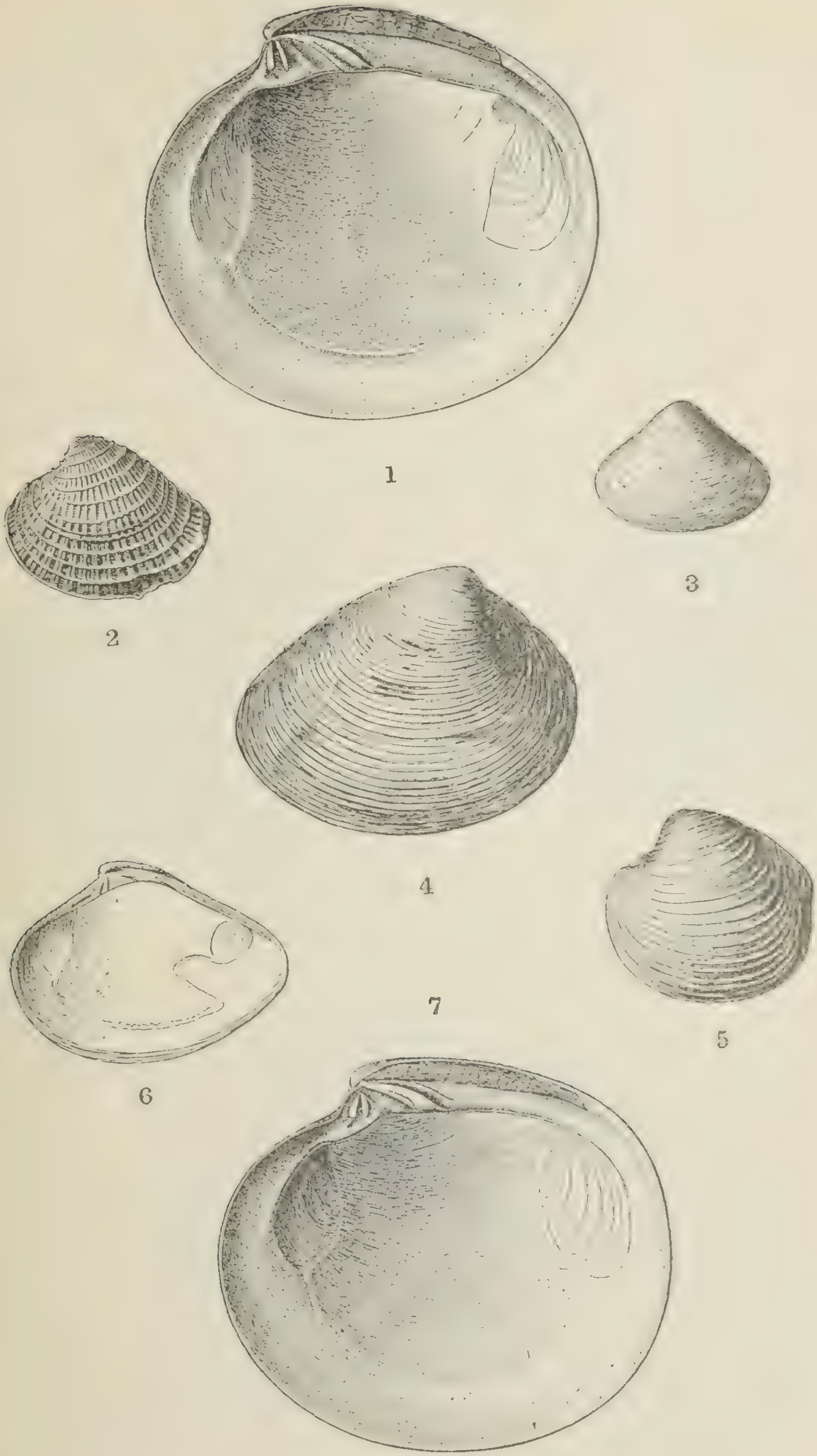
EAST AMERICAN VENERIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 410.



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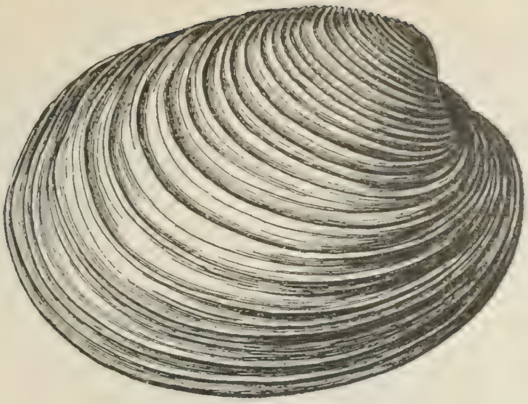
FOR EXPLANATION OF PLATE SEE PAGE 411.



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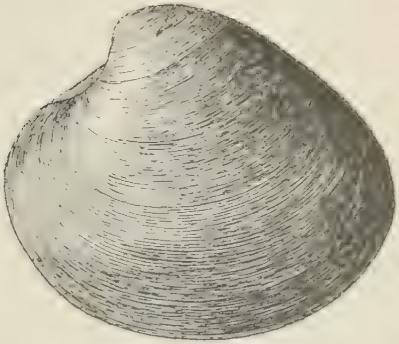

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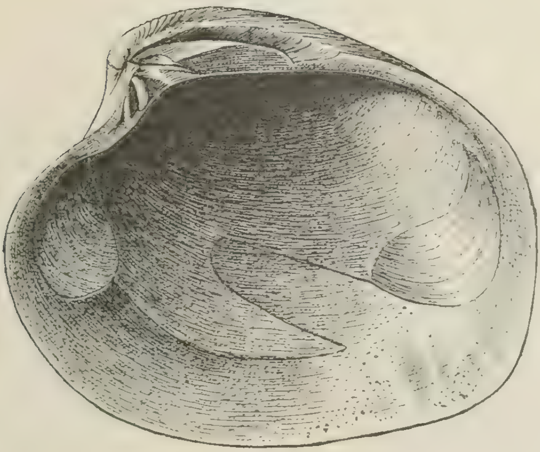

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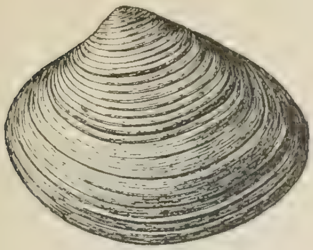

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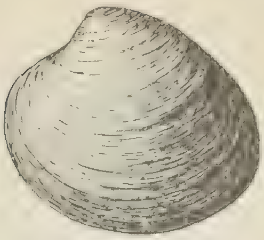

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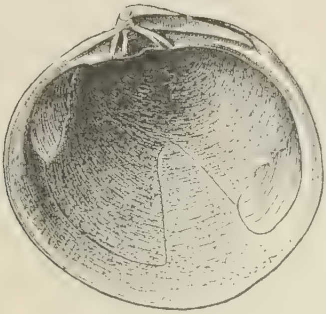

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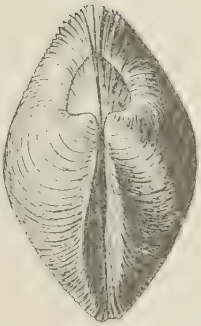

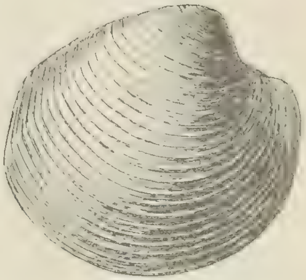

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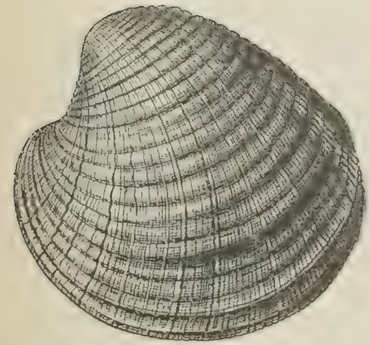

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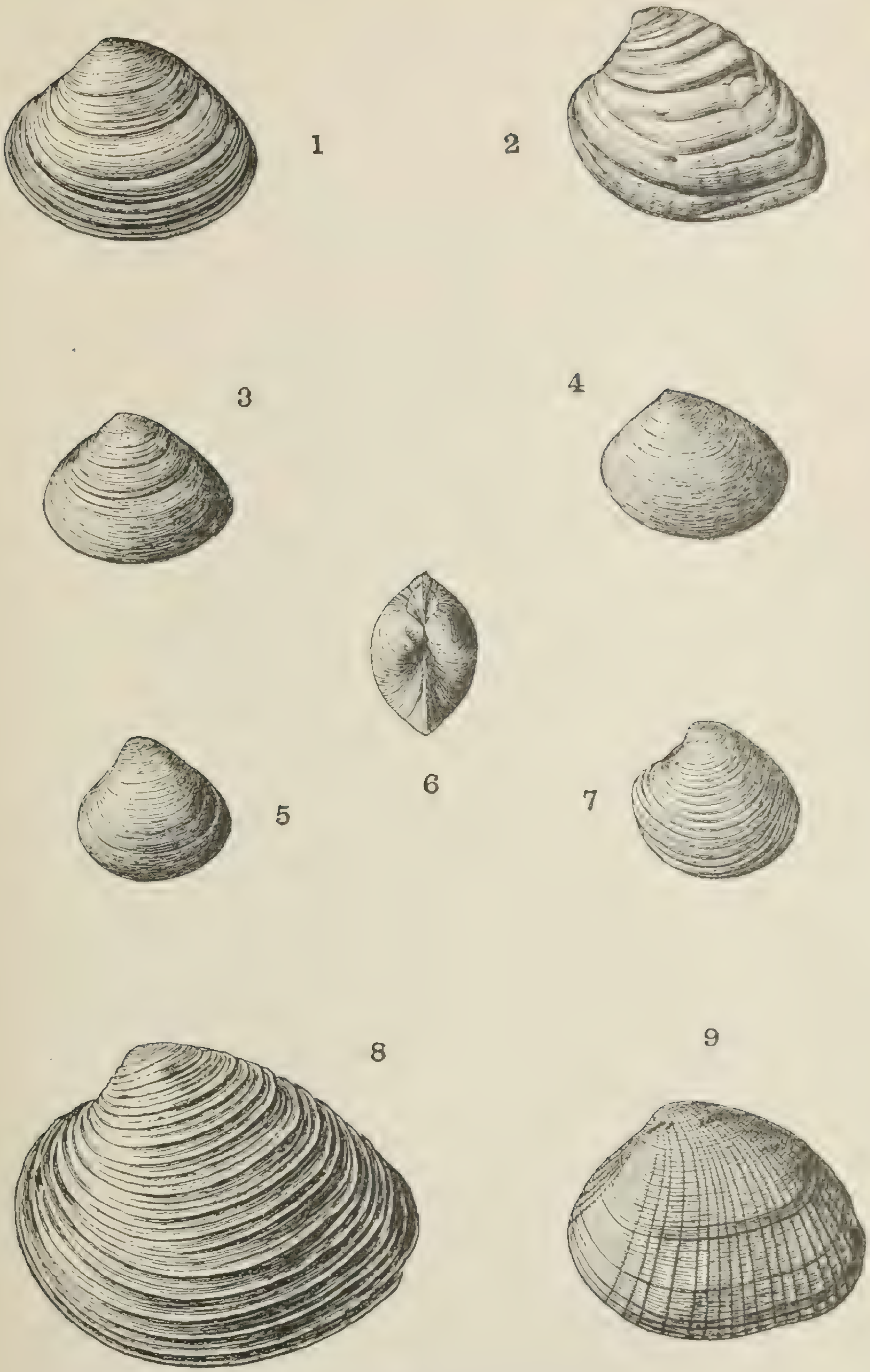
West American Veneridæ.

For explanation of plate see page 411



WEST AMERICAN VENERIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 412.

ON THE LOWER DEVONIC AND ONTARIC FORMATIONS OF MARYLAND.

By Charles Schuchert,

Assistant Curator, Division of Stratigraphic Paleontology.

Cumberland, Maryland, has long been famous for its Oriskany fossils, which were first brought to the attention of paleontologists by Mr. William Andrews, and described by Hall in the third volume of the Paleontology of New York. The Helderbergian fossils are more difficult to secure, and these "Medals of Creation" become more and more rare as one proceeds downward in the section. It is for this reason, as well as for the great amount of folding and sometimes of crumpling to which the formations have been subjected, that the perfect succession of the Ontaric[a] and Lower Devonic rocks of Maryland has so long remained in obscurity. In a general way that succession has been known for many years, but as late as 1897 the term Lewistown formation was used to cover the equivalents of the New York, Niagara, Salina, and Lower Helderberg. Mr. Robert H. Gordon began to collect fossils about Cumberland in 1894, and through him, in the autumn of 1899, my own interest in this locality became so great that since then we have together gone over the sections five times. In the main our studies have been confined to the Helderbergian and Oriskanian deposits, though we have investigated the lower formations often enough to learn that the composite section (p. 422) is essentially correct. In regard to the lower beds of the Ontaric here discussed use has been made of the work of the Maryland Geological Survey, by R. B. Rowe and C. C. O'Harra.

In this connection, I desire to express my indebtedness to Mr. Gordon, whose detailed knowledge of the formations around Cumberland,

[a] The American equivalent for Upper Silurian. For definition of this and the Lower Devonic terms here used see Clarke and Schuchert, Science, December 15, 1899, pp. 874–78.

and whose aid and interest in my work have greatly increased the value of the present paper. The work of the local collectors of Cumberland, Messrs. Frank Hartley, George M. Perdew, and G. M. Roeder, has also been of much benefit. These united efforts have resulted in unearthing many new species and new faunulæ in which the Cystidea form an important part. The best material in the collections has been deposited in the United States National Museum, and will serve as the basis for a monograph of the Ontaric and Lower Devonic fossils of Maryland, now in preparation for the Geological Survey of that State, under the direction of Dr. W. B. Clark.

Cumberland Basin.—The Ontaric and Devonic deposits, from the Juniata to the close of the Oriskany, were laid down in an Appalachian trough, which Ulrich and Schuchert[a] have termed the Cumberland Basin. This basin was bounded on the west by the Helderbergian barrier, which existed possibly from Clinton, but certainly from Niagaran time, and extended from the region of Cayuga Lake, New York, southwestward to west of Altoona, Pennsylvania, through westernmost Maryland, central West Virginia, into eastern Tennessee. To the east of this barrier and about parallel with it was the Appalachian Valley fold. Between these lay the Cumberland Basin, which steadily subsided from early Ontaric time to the close of the Oriskanian. The area of greatest subsidence was in central Pennsylvania (Lewistown), since here occurs the greatest thickness for nearly all the formations. To the north and south the formations pinch out, but during Helderbergian time a transgression sets in which first attains the Mohawk River in New York and subsequently spreads as far south as Hancock County, Tennessee. During the Becraft of Helderbergian time, in the western area of the Cumberland Basin, throughout West Virginia, Maryland, and southern Pennsylvania, little deposition took place, but about 60 miles east conditions were normal and here occur faunas of Becraft time. This sea spread north to the Mohawk River, but south of Covington, Virginia, it had no great extent. In the western area the Lower Oriskany black chert rests conformably upon, but sharply separated from, the late New Scotland shale zone. In the eastern area nothing as yet has been found comparable with the Lower Oriskany of the Cumberland region, and it may be that no deposits of this time were there laid down. During Upper Oriskany time sedimentation was again general and continued until the close of the Maryland Oriskanian. Then a land condition prevailed in this basin south of middle Pennsylvania, throughout Esopus and Onondaga time. To the north of middle Pennsylvania, however, the Oriskanian sea continued, and finally, in late Oriskanian time (Decewville), the Atlantic fauna spread by way of the Mohawk depression into the Mississippian province. The

[a] Report of the New York State Paleontologist, 1901 [1902], pp. 647–652.

Mississippian Middle Devonic transgression did not attain its greatest extent until Marcellus time, when it crossed the Helderbergian barrier and completely invaded the Cumberland Basin as far east as the Appalachian Valley fold. Then the Atlantic fauna again spread into the Marcellus sea of the Mississippian province.

Juniata, Tuscarora, and Niagaran deposits of Cumberland Basin. In the present paper the lower members of the Ontaric will not be further described than to mention that the formations beneath the Salina have a united thickness of 1,934 feet. More detail is given in the composite section (pp. 423–4). The fauna from these formations is at present a small one, and outside of *Arthrophycus harlani*, *Atrypa reticularis*, and *Leptæna rhomboidalis*, all the species appear to be new. While these formations have the position of the New York Medina, Clinton, Rochester, Lockport, and Guelph, they are not all to be called by these names, because, in the absence of characteristic species, the faunas indicate that the Maryland Niagaran deposits belong to another sea province. The conspicuous life element of these sediments is represented by a few species of Ostracoda, which are at times so wonderfully prolific as to make up, in large part, limestone bands 2 to 4 inches thick. These forms appear in the so-called Clinton, attain greater development in the thin limestone bands of the following formation, and in the Salina are the essential fossils, where the small Ostracoda are joined by large *Leperditia*. The other fossils of the lower formations are a few species of brachiopods of the genera *Rhynchonella* and *Rhynchospira;* sometimes quite prolific, and of the trilobites *Calymene*, *Dalmanites*, and *Homalonotus*. This faunal development is wholly unlike that of the Niagaran of the interior United States, and is known to be restricted to the Appalachian region from southern Virginia north into New York. For this area note the absence of the following fossils characteristic of the New York Niagaran: *Spirifer radiatus*, *S. niagarensis*, *S. crispus*, *S. sulcatus*, *Pentamerus oblongus*, *Caryocrinus*, *Eucalyptocrinus*, etc. These facts show that the Maryland faunas were probably derived from the east or the Atlantic during Siluric time, and that this sea then had no communication with the one farther west, which Walcott has called the Mississippian sea.[a]

Salina formation.—Ten miles southwest of Cumberland, along the line of the Baltimore and Ohio Railroad, and a little west of the station of Pinto, Maryland, there is a splendid section of Salina rocks. Every foot of the 1,125 feet in the vertical beds of this formation, which is described in detail in the composite section, can here be studied. The Niagaran deposits are seen to pass without apparent break into the Salina, but no part of its fauna is found higher up.

[a] Proc. Amer. Assoc. Adv. Sci., XLII, June, 1894, pp. 129–169.

unless it be a few of the Ostracoda which remain undetermined. The lower 400 feet of the Salina formation are characterized by Ostracoda, particularly the lowest 130 feet, or the cement beds, where these small crustaceans are often present in considerable numbers. Not a fragment of *Eurypterus* has been secured here.

The next 285 feet introduce a very meager fauna, a small *Meristella* predominating and becoming the common fossil in the higher beds. Here also has been found a single plate of the fish *Palæaspis bitruncata*. Just above, or about 700 feet above the base of the formation, there is a well-marked, but thin, fossiliferous zone, having small *Rhynchonella lamellata* in abundance, a *Rhynchospira* recalling *R. globosa*, a small *Meristella*, *Orthothetes*, new species; *Murchisonia*, a small *Modiolopsis*-like bivalve, and, rarely, *Tentaculites gyracanthus*. Above this horizon for nearly 425 feet no fossils other than the small *Meristella* have been found. Then a prolific fauna indicating the Manlius formation rapidly makes its appearance.

The Salina formation of Maryland is a continuous series of deposits, and appears to be the equivalent not only of all the Salina and Waterlime of New York, but also includes the hiatus between the Waterlime beds with *Eurypterus* and the "Bull Head" rock of western New York correlated with the Manlius. In eastern New York the whole of the Salina lies beneath the "Corralline limestone" of the Schoharie section, yet some of the diagnostic fossils of this zone occur in Maryland at the base of the next, or Manlius, formation as here defined. In New Jersey it appears that all of Weller's "Decker Ferry formation," from what he calls the "Bossardville limestone," up to the "Coralline limestone" bed of his "Rhynchonella lamellata zone," representing a thickness of 42 feet, includes the horizon either of our bed *5a* of the Salina formation, or part of this zone and our *4f* of the Manlius. It seems hardly probable that all of Weller's Decker Ferry is so young as the base of the Maryland Manlius, for if it were one would expect to find some of the cystids, especially *Sphærocystites*, the leading fossil of the lower Manlius. In any event this formation is either transitional to or lies partly in our basal member of the Manlius. This correlation is further supported by a study of a number of sections extending from southern Pennsylvania into New Jersey, and thence to the type locality of Schoharie, New York. These sections will be published elsewhere.

The Salina of Maryland is continuous with that of Pennsylvania, where it attains a thickness of 1,600 feet in Perry County. Parts of it have received various names, as Bloomsburg red shale, Bridgeport sandstone (= Lower Salina), and Bloomfield or Landisburg sandstone (= Middle Salina). In Pennsylvania, as in Maryland, the formation is devoid of *Eurypterus* (except at Selinsgrove Junction, where were found a few thoracic segments), but it abounds in large *Leperditia*

and, rarely, in *Palæaspis*. The Pennsylvania Salina unites the deposits of New York with those of Maryland and the Virginias.

Manlius formation.—This formation has in Maryland a thickness of about 110 feet and consists, as a rule, of thin-bedded, impure limestones, which in the lower third are more shale than limestone. It should be said in this connection that there is no natural line or lithologic difference by which the Manlius can be separated from the Salina below or from the Coeymans above. The sequence of deposition is here continuous, and there was no marked physical event in the Cumberland Basin to cause a change in the lithology at this time. Our line of separation is therefore somewhat arbitrary, and is based on the first abundant occurrence of fossils of the type of the New York Manlius, a criterion of unequal value in different places. The early abundance of life in this horizon recalls the "Coralline limestone" fauna of New York, and it soon is blended with the Bryozoa and cystid fauna found a little higher in the lower third of the Manlius.

At Pinto, Maryland, near the base of the Manlius, occurs a great abundance of *Cladopora rectilineata* Simpson, one of the guiding fossils for these beds. It is also found at Cash Valley, near Cumberland, at about the same zone, where occasionally are obtained *Acervularia* (?) *inæqualis* Hall, *Halysites*, and *Chonetes jerseyensis*, three of the leading fossils of the "Coralline limestone" of Schoharie, New York. At this locality *Spirifer octocostatus*, *Nucleospira cf. ventricosa*, and *Rhynchonella* approaching *R. campbellana* are likewise found.

Near the middle of the Manlius there is a zone of hard, massive, dark blue limestone, well shown near the Market street bridge, in the city of Cumberland. It was from this place and horizon that Mr. Andrews collected some of his "Lower Helderberg" fossils, which were described as such by Hall. They are *Merista typa*, *M. camura*, *Spirifer modestus*, *S. octocostatus*, and *Strophonella geniculata*. None of these species are known to occur outside of the Manlius, and they must therefore be eliminated from the Helderbergian as now restricted, which begins with the next formation or Coeymans. The exact locality of the type specimen of *Sphærocystites multifasciatus* is not known, but it could have been found only in the Manlius horizon about Cumberland.

In the ballast quarries of the Baltimore and Ohio Railroad, near Keyser, West Virginia,[a] may be seen to good advantage an extended section not only of the Manlius and about 100 feet of the Salina, but also of the entire Coeymans and New Scotland formations. The lowest zone (4*f*) does not yield the corals of the "Coralline" horizon,

[a] It is reported that this railroad had spent upward of $2,000,000 in this quarry during the past three years. The great amount of work thus represented has made it possible to gather a new and unique Manlius fauna.

but the brachiopods associated with them, and mentioned above, occur here.

Zone 4*d* is the most interesting faunally, and is marked by a great abundance of the cystid *Sphærocystites multifasciatus*. Associated with this species, but as a rule far less abundant, occur ten new species of cystids, several new crinoids, *Spirifer modestus* and *S. vanuxemi* in profusion, *Rhynchotrema formosa*, and many other forms. Immediately above (4*e*) occur numerous fine specimens of that little-understood fossil *Camarocrinus*; also *Calymene camerata* and *Tentaculites gyracanthus*. Then comes a zone with a new form of *Gypidula* near *G. galeata*.

The Manlius may also be studied to advantage at the Devil's Back Bone near Cumberland. At this point the formation is less shaly, with more pure dark blue limestone, and the fauna is somewhat different because the fossils are derived from slightly different horizons than at the Keyser quarries. For the sake of completeness the Manlius part of the section is here given:

D. B. B. *a*. Thin-bedded shaly limestone abounding in Bryozoa of the genera *Fenestella*, *Polypora*, *Ptilodictya*, *Orthopora*, *Drymotrypa*, *Stictoporina*, *Batostomella*, and *Lioclema*; also *Orthothetes deformis*, *Rhynchotrema formosa*, and very rarely *Sphærocystites multifasciatus* .... 32 feet.

D. B. B. *b*. Massive hard dark blue limestone, the upper 7 feet abounding in a new form of *Gypidula*. Just below this horizon are found *Merista typa*, *Spirifer modestus*, *S. vanuxemi*, *Strophonella geniculata*, *Orthothetes deformis*, and rarely *Tentaculites gyracanthus* .... 26 feet.

D. B. B. *c*. Thin-bedded limestone with slender Bryozoa of the genus *Orthopora* and rarely a *Camarocrinus* .... 32 feet.

About 20 feet more of the beds below are regarded as Manlius.

From this it is seen that the faunulæ of the Manlius are not constant even within so small an area as 25 miles around Cumberland. For instance, at Keyser, West Virginia, the lower third swarms with cystids, while elsewhere these fossils are very rare. At the Devil's Back Bone there is a bed 7 feet thick abounding in a *Gypidula* of small size. At Keyser this form is found higher up and has increased in size, while near Pinto it is found still higher and has developed into the almost typical *Gypidula galeata* of the Coeymans. As a rule, *Stromatopora* does not develop abundantly in the Manlius, and yet near Hyndman, Pennsylvania, just over the Maryland line, there is a bed 5 feet thick composed of this form (see section on p. 419). Generally, however, most of the fossils occur in a restricted zone, and the difference in the faunulæ is probably due to the greater local development of certain groups, as the Cystidea, Brachiopoda, Bryozoa, and, more rarely, *Stromatopora*.

Coeymans limestone.—This formation throughout Maryland is fairly constant in its lithologic aspect, being a purer, heavier bedded, and tougher limestone than the Manlius. Faunally it is, as a rule, easily recognized by the *Stromatopora* beds, which weather out as curly or

nodular masses. In the vicinity of Cumberland there are two *Stromatopora* beds, fairly constant in their position, but at Keyser, West Virginia, they are nearly obsolete. On the other hand, at Hyndman, Pennsylvania, a few miles north of Cumberland, specimens of *Stromatopora* are exceedingly prolific, and to bring out this development the following section is given, based on two quarries just back of the village. The strata are nearly vertical:

Coeymans about 110 feet.	Partially covered slope of hill over which occur many pieces of *Stromatopora*	30 feet.
	Upper quarry zone	24 feet.
	Both walls of this quarry and the intermediate limestone are filled with masses of *Stromatopora* of two species. Here also are found *Favosites*, *Aulopora*, *Rhynchospira*, etc.	
	Covered area	90 feet.
	Stromatopora also occurs abundantly here.	
Manlius about 110 ft.	Lower quarry zone	33 feet.
	The upper 10 feet of limestone have an abundance of a small form of *Gypidula galeata*. The lower 5 feet abound in *Stromatopora*.	
	Thin-bedded limestone and shales, about	30 feet.
	The fossils are those of the cystid zone of the Keyser quarries.	
Salina.	Nodular limestone, quarried	50 feet.
	Thin-bedded dark blue limestone containing *Leperditia*. This is the transition zone to the Salina formation.	

New Scotland and Becraft limestone.—The Coeymans limestone passes without break into the New Scotland. In the upper 15 to 20 feet of the former the typical Helderbergian fauna appears, yet the diagnostic fossil *Spirifer macropleura* is not found here, but above, in the massive gray cherty limestone from 40 to 50 feet in thickness. This limestone is very constant in occurrence throughout western Maryland, and may be seen to best advantage in the Corrigansville quarry near Cumberland, and again at the Twenty-first Bridge of the Baltimore and Ohio Railroad, near Keyser, West Virginia.

The fossils thus far secured are those of the typical area for this horizon in Albany County, New York. Almost nothing new occurs in Maryland, but a marked difference in this fauna is the almost total absence of the prolific bryozoan development of New York.

These heavy-bedded cherty limestones gradually pass upward into shales, of which 20 feet are present in western Maryland. They, in part at least, belong with the New Scotland, since *Spirifer macropleura* has here been found in the lower third. Less than 60 miles to the east of Cumberland, at Cherry Run, West Virginia, the New Scotland limestone (there is no shale present) continues without break into the gray arenaceous Becraft, and here may be gathered a fauna not to be had about Cumberland. This occurrence shows that while the Helderbergian sea was continuous east of Cumberland, west of it there may have been land conditions or possibly a shallow sea in which almost no deposits were laid down. At several localities, how-

ever, more than 20 miles apart, this New Scotland shale horizon is always about 20 feet thick, upon which follows conformably, but with a sharp lithologic difference, the black siliceous shale of the Lower Oriskany.

A noteworthy fact connected with these shales at Twenty-first Bridge is the occurrence of manganese-phosphatic nodules, which have the general aspect of those dredged from the present deep seas. These, however, in this case do not indicate deep waters, since the stratigraphic evidence denotes a shallow sea before and after New Scotland time in the Cumberland area.

Oriskany formation. In western Maryland, upon the shale beds of the New Scotland, and sharply separated from it, lies the black siliceous shale with a meager fauna. That collected recalls the Oriskany of Camden, Tennessee, and point to an older stage than the Oriskany as usually known. This horizon gradually passes upward into the arenaceous limestone containing the well-known Oriskany fauna. It does not, however, occur in full force until nearly 200 feet above the base of the formation, and the fauna then continues through the upper 150 feet. It is these uppermost Oriskany beds, just across from Cumberland, along the banks of the Potomac in West Virginia, which now furnish the local collectors with fine fossils. Mr. Andrews, however, secured the specimens described by Hall mainly from two quarries, now abandoned, in the city of Cumberland. One of these is on Green street, below the Episcopal Church, and the other is back of the German Lutheran Church. Both are in the upper 75 feet of the Oriskany, as in the Green street quarry the Marcellus shales plainly mark the top for measurement. However, at these quarries, and particularly in the one back of the German Lutheran Church, on Schriver's hill, the excavation was carried far below the surface into lower layers that are not shown in West Virginia. This explains why certain forms, as *Spirifer cumberlandiæ*, *S. tribulis*, etc., no longer, or but rarely, are found about Cumberland.

A peculiar condition of leaching of the Oriskany in this locality has made it possible to secure its fossils, completely weathered out of the inclosing rock, as siliceous pseudomorphs. This condition is restricted to Cumberland, and the reason for it will be shown presently. So many of these delicate fossils have been sent out by local collectors that it has become a general belief that they can be secured anywhere in the Oriskany of Maryland. Regarding this preservation Hall[a] has written:

> While in the State of New York the accessible portions of the rock furnish us for the most part with casts of its fossils, or, if beyond the reach of weathering, with a compact mass of calcareous sandstone in which the fossil remains are closely

[a] Paleontology of New York, III, pp. 401–402.

imbedded, we find, in Maryland and some parts of Virginia, that in the friable sandstone the shells are entirely silicified and quite free from adhering stone, so that the exterior markings and internal structure are perfectly preserved; the interior being quite hollow, or filled only with loose sand. In these localities, not only do we find the cavities of large gasteropods with no more adhering matter than those of the Tertiary sands, but more unfrequently the delicate internal apparatus of the Brachiopod is almost entirely preserved.

Mr. R. B. Rowe[a] was the first to explain the cause for this restricted leaching out of the Oriskany fossils and their occurrence in "sand pockets." He writes:

Most of the fine collecting grounds for Oriskany fossils in this region are within five or ten minutes walk from the hotels in Cumberland. The disintegration of the sandstone has been carried on there much more completely than at any other place, and has been due, no doubt, to the cutting of the Potomac River and Wills Creek across Knobley Mountain and Shrivers Ridge.

The constant downward percolation of the water from the Potomac River and Wills Creek, when both flowed over this part of Cumberland, has carried away the calcareous material of the Oriskany arenaceous limestone and the fossils, and has partially replaced the latter with silica. As leaching continued, all the calcareous material was finally removed and more or less large, partially empty pockets or caves were formed, filled with loose sand, in which the fossils are found at times in considerable quantity.

In western Maryland the Oriskanian is present in greatest volume, and it continues so both to the north and south along the strike of the Cumberland Appalachian folds. Eastward the lower black shale rapidly disappears, and at its most eastern outcrops the upper portion is generally much reduced in thickness and the calcareous material is usually absent. Here the Oriskany closely resembles the Tuscarora sandstone near the base of the Ontaric. The most easterly locality for the Oriskany, near the old shore line, shows a depth of only 50 feet, while but 8 miles west, at Hancock, it is 225 feet thick.

The thickness of the Oriskany is variable. On the Winchester road, at Pinto, the Upper Oriskany is almost entirely absent. At the Devils Back Bone it also is decidedly thinner than at Ridgely. These facts lend additional support to the evidence that western Maryland was a land area during Onondaga time, when the Oriskany formation was locally considerably removed.

The small Lower Oriskany fauna thus far collected is nearly all new, and the Upper Oriskany, also, has yielded a number of new forms since Mr. Andrews made his collection.

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[a] The Paleodevonic formations of Maryland, a study of their stratigraphy and faunas. A dissertation presented to the board of University Studies of the Johns Hopkins University for the degree of Doctor of Philosophy, May, 1900. This thesis will be published by the Geological Survey of Maryland in the volume devoted to the Devonic formations.

COMPOSITE SECTION OF THE LOWER DEVONIC AND ONTARIC OF MARYLAND.

The Marcellus stage of the Middle Devonic rests directly upon the eroded Oriskanian. No Esopus, Schoharie, or Onondaga deposits occur in Maryland or farther south.

Correlations with New York.	Locality for sections.	DESCRIPTIONS OF HORIZONS.
Upper Oriskanian, 258 feet. (Or typical Oriskany.)	Twenty-first Bridge, West Virginia.	1*a*. Heavy-bedded arenaceous limestone, gradually changing downward into a black chert or siliceous shale. In the lowest beds are found *Spirifer cumberlandiæ*, *S. concinnoides*, and *Eatonia sinuata*. Fossils, however, are rare until 100 feet above the base of this division, where the characterizing *Hipparionyx* fauna attains greater individual and specific representation, culminating in the upper 100 feet, the present source for nearly all of the Cumberland Oriskanian fossils.......................................258 feet.
Lower Oriskanian, 99 feet. (Or Camden.)	Twenty-first Bridge, West Virginia.	1*b*. Bedded and nodular black chert and siliceous shale, with a sparse fauna distinct from the *Hipparionyx* fauna above and from the Helderbergian below...90 feet. Near the base are found *Anoplotheca flabellites*, *Leptostrophia arctimuscula*, and Ostracoda. Just below the middle occur *A. flabellites*, *Spirifer tribulis*, *S. paucicostata*, *Beachia suessana immatura*, *Anoplia nucleata*, *Pholidops multilamellosa*, *Tentaculites acula*, and *Diaphorostoma desmatum*. Near the top is an abundance of Ostracoda and *Chonetes hudsonica*.
		(In western Maryland the Becraft is not present or is not normally developed. Ninety miles east occur the following beds, completing the interval:)
Becraft, 85 feet.	Cherry Run, West Virginia.	2*a*. Dark blue arenaceous limestone, with lumps of black chert. The fauna is most abundant in the upper half, where *Rensselæria æquiradiata* is the characteristic fossil. No *Spirifer macropleura* occur here....about 85 feet. Other fossils are *Rhipidomella assimilis*, *Rhynchonella eminens*, large *Eatonia medialis*, small *A. flabellites*, *Spirifer cyclopterus*, *S. concinnus*, *Cyrtina rostrata*, etc.
		(The remainder of the section is complete in western Maryland.)
New Scotland, 64 feet.	Twenty-first Bridge, West Virginia.	2*b*. Soft, bluish argillaceous shales, with some harder layers and occasional manganese-phosphatic nodules; *Chonetes helderbergiæ* Rowe, *Meristella arcuata*, *Trematospira multistriata*, *Spirifer macropleura*, *Orthothetes woolworthanus*, *Stropheodonta becki*, etc ....20 feet. 2*c*. Massive gray limestone, with bands of chert, becoming thin-bedded above, with partings of shale; characterized by *Spirifer macropleura* ....44 feet. The fauna can be collected to better advantage around Cumberland. Some of the species are *Edriocrinus pocilliformis*, *Dalmanella perelegans*, *Rhipidomella oblata*, *Eatonia singularis*, *E. peculiaris*, *E. medialis*, *Anoplotheca concava*, *Trematospira multistriata*, *Parazyga deweyi*, *Spirifer perlamellosus*, *S. macropleura*, *S. cyclopterus*, *Platyceras spirale*, *Phacops logani*, etc.
Coeymans, about 110 feet.	Devils Back Bone, near Cumberland, Maryland.	3*a*. Massive, regularly bedded, blue-gray limestone. It is the prominent ridge of the "Devils Back Bone," near Cumberland. At the top are found typical *Gypidula galeata*, *Spirifer cyclopterus*, and stems of *Lepadocrinus* ....16 feet. 3*b*. Shaly limestone without fossils..............................1 foot 6 inches. 3*c*. Massive, regularly bedded, blue-gray, unfossiliferous limestone ....22 feet. 3*d*. Heavy-bedded nodular limestone, filled with *Stromatopora* (locally known as the first *Stromatopora* bed) ....7 feet 6 inches. 3*e*. Heavy-bedded blue limestone, almost without *Stromatopora*..........25 feet.

Composite section—Continued.

Correlations with New York.	Locality for sections.	DESCRIPTIONS OF HORIZONS.
Coeymans, about 110 feet.	Devils Back Bone, near Cumberland, Maryland.	3*f*. Second *Stromatopora* bed, abounding in a few species of corals........9 feet. (At Keyser at about this zone occur vast numbers of *Tentaculites gyracanthus*.) 3*g*. Thin-bedded nodular limestone, with occasional *Stromatopora*........10 feet. 3*h*. Heavy-bedded grayish limestone, with layers of chert more prominent above and below. Fossils rare. *Atrypa reticularis* and *L. rhomboidalis*. 32 feet 6 inches. (It is probable that a part of this zone is represented in 4*a* of the next section, near Keyser, West Virginia.) Base of Devonic.
Manlius, about 110 feet.	Baltimore and Ohio ballast quarries near Keyser, West Virginia.	Top of Ontaric. No break in deposition. 4*a*. Heavy-bedded solid blue limestone. No fossils seen........34 feet 6 inches. 4*b*. A solid blue limestone, filled with a small form of *Gypidula* near *G. galeata*........2 feet. 4*c*. Heavy-bedded impure limestone, with an abundance of *Camarocrinus* and more rarely *Tentaculites gyracanthus*, *Calymene camerata*, and a new species of cystid........6 feet. 4*d*. Thin-bedded shaly limestone and shale deeply weathered. Throughout this zone *Sphærocystites multifasciatus* abounds in great numbers with *Spirifer modestus*, *Rhynchonella formosa*, etc........37 feet. 4*e*. A solid blue limestone........2 feet 4 inches. 4*f*. Thin-bedded shaly limestone like 4*d*. Toward the base occur *Nucleospira*, *Rhynchonella* like *campbellana*, and *Spirifer octocostatus*...28 feet 6 inches. (The upper part of the following or Pinto section terminates at the Winchester road, where the lowest Manlius abounds in *Cladopora rectilineata*, *Favosites helderbergiæ præcedens*, and the brachiopods just mentioned.)
Salina, 1,125 feet.	Pinto, Maryland, along Baltimore and Ohio Railroad.	5*a*. Massive light-gray limestone, becoming more and more nodular toward the top. The only fossil seen is a bryozoan, *Cyphotrypa*, new species...95 feet. 5*b*. At base, thin-bedded gray limestone, changing to shales in the upper half; fossils obscure, almost absent........210 feet. 5*c*. Thin-bedded dark-blue limestone. Toward the base occur rarely *Tentaculites gyracanthus*; more commonly *Orthothetes*, new species, *Rhynchonella lamellata*, small *Meristella*, *Rhynchospira*, *Murchisonia*, and ostracods of the genera *Bollia* (near *B. clarkei* of the Niagara) and *Klœdenia*........135 feet. 5*d*. Thin-bedded dark-blue limestone, with occasional papery shales; small *Meristella* and *Leperditia*. A single plate of *Palæaspis bitruncata* was found here........85 feet. 5*e*. Thin-bedded ribbon limestone weathering into pinnacles; small *Meristella* and *Leperditia* like *alta* common........200 feet. 5*f*. Thin-bedded, somewhat crumpled, dark-blue shales with thin bands of limestone........50 feet 5*g*. Calcareous shales, dark blue in color, with thin bands of limestone, dolomite, and occasional sandstones; *Leperditia*........200 feet. 5*h*. Fourth cement rock; *Leperditia* common........15 feet. 5*i*. Blue-gray shales, with thin arenaceous and calcareous layers........16 feet. 5*j*. Third cement rock........11 feet. 5*k*. Greenish shales with some calcareous and arenaceous layers; Ostracoda. 55 feet. 5*l*. Second cement rock; *Leperditia* and *Bollia*........18 feet. 5*m*. Massive magnesian limestone toward the top, with beds of shale toward the bottom; Ostracoda........14 feet. 5*n*. First cement rock; *Bollia*, *Beyrichia*, and *Leperditia*........9 feet. 5*o*. Greenish-gray and mottled dark-brown and olive sandstones..3 feet 6 inches. 5*p*. Disintegrated yellow rock. First occurrence in this section of *Leperditia*, which is abundant along with *Bollia* near *B. clarkei* and *Octonaria*..8 feet.

Composite section—Continued.

Correlations with New York.	Locality for sections.	DESCRIPTIONS OF HORIZONS.
Upper Niagaran, 333 feet.	Pinto, Maryland, along Baltimore and Ohio Railroad. (Emended after Rowe, Maryland Survey, Allegany County, p. 92.)	*6a.* Thin-bedded sandstones ....2 feet 6 inches *6b.* Grayish-black shales abounding in poorly preserved Bryozoa. 13 feet 6 inches. *6c.* Black shales, with thin bands of sandstone and some layers of limestone; Ostracoda abundant..22 feet. *6d.* Thin-bedded dark-blue limestone; fossils common toward the bottom; *Ostracoda* in great profusion, *Rhynchonella*, *Rhynchospira*, *Tentaculites*, etc. 225 feet. *6e.* Dark-blue limestone with thin shale partings; much folded. (Spring here.) Thickness estimated ....70 feet. (The Pinto section continues exposed for 159 feet lower. The remainder of the section is again taken up 10 miles east, at Wills Creek, near Cumberland, and is supposed to include the above-mentioned 159 feet of the Pinto section.)
Lower Niagaran, 584 feet.	South side of Wills Creek, near Cumberland, Maryland. (After Maryland Survey, Allegany County, p. 91.)	*7a.* Shales and fossiliferous limestone, mostly concealed ....33 feet. *7b.* Reddish shale, with a few thin limestone bands (concealed in part; may contain the upper iron-ore band of 6 inches)..........................29 feet. *7c.* Fossiliferous gray shale and blue limestone, with 5½ feet of shaly sandstone near the bottom ....28 feet. *7d.* Reddish fossiliferous shale ....24 feet. *7e.* Concealed ....238 feet. *7f.* Lower fossiliferous ore ....10 feet. *7g.* Rusty olive shale ....17 feet. *7h.* Fossiliferous olive-colored shale ....85 feet. *7i.* Rusty shales above, followed by gray sandstone interstratified with olive shales..36 feet. *7j.* Olive-colored shales, with thin beds of brownish-gray quartzite......27 feet.
Tuscarora of Pennsylvania.	Wills Creek gorge.	8. Snow-white to light-gray quartzite, in places a fine conglomerate; *Arthrophycus harlani*, the only fossil...287 feet.
Juniata of Pennsylvania.	Wills Creek gorge.	9. Interbedded dull red sandstones and shales. In Wills Creek gorge 530 feet can be seen, but the total thickness, on the basis of that in Bedford County, Pennsylvania, is probably not less than 730 feet.

"Hudson River shales."

OBSERVATIONS ON THE NUMBER OF YOUNG OF THE LASIURINE BATS.

By Marcus Ward Lyon, Jr.,

Aid, Division of Mammals.

There is a very general belief that the number of young produced at a birth by bats is usually one, or at most two, so that a recent writer[a] says: "Such an occurrence as four young in a bat is, I believe, unheard of;" and rather doubts the correctness of the observations of an experienced collector who recorded an adult female of *Lasiurus borealis salinæ* with that number of young.

While the rule for most bats is one or sometimes two offspring at parturition, yet a careful examination of material and the literature shows the number of young produced at a time by members of the genus *Lasiurus* and probably *Dasypterus* is usually double that number. This might safely be inferred from the fact that four mammæ are found in bats of this group, as has been noted by several writers.[b] In all other bats, so far as the writer is aware, there are two mammæ, each of which is placed near the middle of the outer border of the pectoral muscle. In the Lasiurine bats, in addition to these two, there is a second pair, located more posteriorly, each mamma of which is nearer the back and pretty well up under the wing. (See fig. 3, Plate XVII.)

As to the number of young in *Lasiurus*, Professor Wilder found three embryos in each of two specimens of *L. borealis* from Massachusetts. Dr. Harrison Allen[c] refers to two embryos of *L. borealis* as twins. An examination of the material in the U. S. National Museum gives the following results: A pregnant female of *Lasiurus blossevillei* from Paraguay (No. 105631) shows on dissection three well-developed fetuses, each with its own membranes and placenta. There are also in alcohol three embryos from the same locality (Nos. 105636–8), which the collector, Mr. W. T. Foster, says were taken

[a] Oldfield Thomas, Ann. Mag. Nat. Hist., 7th ser., IX, April, 1902, p. 238.

[b] Wilder, Popular Science Monthly, VII, 1875, p. 652. Merriam, Mammals of the Adirondacks, Trans. Linn. Soc., New York, II, 1886, p. 81. Miller, North American Fauna, No. 13, October 16, 1897, pp. 105, 115.

[c] Contrib. Zool. Lab. Univ. Penn., I, 1895, No. 2, p. 22.

from No. 105586, an adult female of *L. blossevillei*. The embryos are all united by shreds of membranes and uterus, so that there is no doubt they came from one parent. A specimen of *L. borealis* from Illinois (No. 14273), preserved in alcohol contains two fetuses.

The most interesting specimens in this connection are Nos. 114044–48, an adult female nursing four young, brought into the National Museum alive by Mr. J. C. Lawson, of Washington, District of Columbia, on June 18, 1902. Photographs of the living family were secured shortly before the mother's death and are reproduced in Plate XVII. A young one was at each of the adult's nipples, where it held on with great tenacity, having in its mouth a good deal of its mother's hair into which its hooked milk teeth firmly caught. As Dobson has suggested, it is probably for the purpose of holding securely to their mothers that the milk teeth of bats differ in form from those of other mammals.

The following table shows the weights (taken while living) and sizes of the family. It is seen that the young ones were less than a third grown as to weight and about half grown as to linear measurements. The combined weights of the four young amounted to 12.7 grams, while the mother weighed but 11 grams.

Mother and young of Lasiurus borealis.

Description.	Weight.	Length, body.	Tail.	Forearm.
	Grams.	*mm.*	*mm.*	*mm.*
114044, adult female	11.0	58	48	41
114045, young female	3.5	34	18	22
114046, young female	3.5	33	18	22
114047, young female	3.0	33	16	20
114048, young male	2.7	34	18	21

No direct observations have as yet been made on the breeding of *Lasiurus cinereus* and *Dasypterus intermedius*, and there are no examples of pregnant females of these bats in the National Museum collection, but it seems safe to predict that when the right material is obtained and good observations made it will be found that the females of these species bring forth as many young at a birth as do those of the *Lasiurus borealis* group.

EXPLANATION OF PLATE XVII.

All the figures are reproduced from photographs taken by Mr. Dodge, of the department of photography.

Fig. 1. *Lasiurus borealis*, from Washington, District of Columbia, mother with four young (Nos. 114044–48) photographed while alive, lying on her back. The interfemoral membrane is held out to prevent her from partly covering the young with it. About seven-eighths natural size.

Fig. 2. The same, mother with the four young attached hanging from a twig. About three-fourths natural size.

Fig. 3. *Dasypterus intermedius*, adult female in alcohol (No. 59533), showing the two mammæ of the left side. The hair has evidently been worn away from around the nipples by nursing young. About five-sixths natural size.

1 2 3

FEMALES AND YOUNG OF LASIURINE BATS.

FOR EXPLANATION OF PLATE SEE PAGE 426.

NOTE ON THE SEA ANEMONE, SAGARTIA PAGURI VERRILL.

By J. Playfair McMurrich,
Of the University of Michigan.

In 1869 Verrill described briefly an actinian obtained by Stimpson in the China Sea, where it was found adherent to the chela of the pagurid *Diogenes edwardsii* (De Haan). It had been termed in manuscript by Stimpson *Carcinophilus paguri*, but Verrill correctly, though evidently with some doubt, referred it to the genus *Sagartia*.[a]

Specimens of *Diogenes edwardsii* collected by Messrs. Jordan and Snyder at Wakanoura, Kii, Japan, and now in the National Museum, bore upon the larger chela and also upon the shell which they inhabited an actinian, specimens of which were sent me for identification by the U. S. National Museum. They proved to be the species described by Verrill, and since the original description contains no details regarding the anatomical characteristics, it has seemed advisable to make a brief statement concerning these.

The base is adherent, broader than the column and thin; no definite chitinous membrane, secreted by the base, was observed. The column is low, forming in the contracted specimens a low dome, or in the more expanded individuals a short cylinder. The walls are destitute of tubercles or verrucæ and showed on surface view no indications of cinclides, although Verrill was able to distinguish these structures in the individuals he examined, stating that "openings, which appear to be cinclides, are sparingly scattered over the surface, arranged in imperfect rows." They are undoubtedly present, since I observed one in sections of the column wall; it had an acontium lying in it and seemed to be an ectodermal invagination.

The margin is smooth and there is no fosse. The tentacles are slightly exposed in all the specimens; they are short and conical and about ninety-six in number.

Verrill describes the coloration of Stimpson's specimens to have

[a] A. E. Verrill, Synopsis of the Polyps and Corals of the North Pacific Exploring Expedition, under Commodore C. Ringgold and Capt. John Rodgers, U. S. Navy, from 1853–1856. Collected by Dr. William Stimpson, Naturalist to the Expedition. Proc. Essex Inst., VI, 1869.

been "pale orange, in contraction cream colored above, brown below. Tentacles pale, annulated with two or three gray rings; inside blackish." In the present specimens the color is a uniform dark chocolate brown. In the endoderm of the tentacles granules of dark brown pigment occur, arranged in a characteristic manner. They form two streaks, varying in breadth, situated either one on each side of the median line of the oral surface of the tentacle (fig. 1) or else along its lateral surfaces, and they seem to vary somewhat in breadth. This arrangement corresponds with Verrill's statement as to the blackish coloration of the inner surfaces of the tentacles, but I was not able to determine the existence of the gray rings which he mentions.

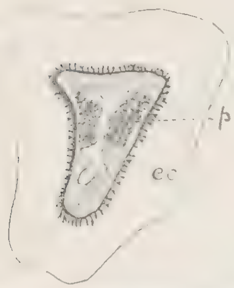

FIG. 1.—CROSS-SECTION OF TENTACLE OF *Sagartia paguri*; *ec*, ECTODERM; *p*, DARK BROWN PIGMENT IN ENDODERM.

The base of the largest individual measured 2.2 cm. in diameter and the height of the column (contracted) 0.5 cm.

The ectoderm of the column wall is thinner than the mesoglœa, which on its outer surface is raised into numerous horizontal ridges. The circular musculature is rather feeble, but the sphincter is strong and of the form represented in fig. 2. The longitudinal muscles of the tentacles are moderately developed and are ectodermal in position (fig. 1).

The stomatodæum possesses two pairs of but moderately developed siphonoglyphs. The mesenteries are arranged hexamerously in four cycles with, in some individuals, occasional representatives of a fifth. The first and second cycles are perfect. The longitudinal muscles are well developed and end abruptly at their inner edges, while externally they taper gradually; the parietobasilars and basilars are feeble, and indeed hardly noticeable.

Reproductive elements were found only on the mesenteries of the third and fourth cycles. Acontia were present but were not abundant.

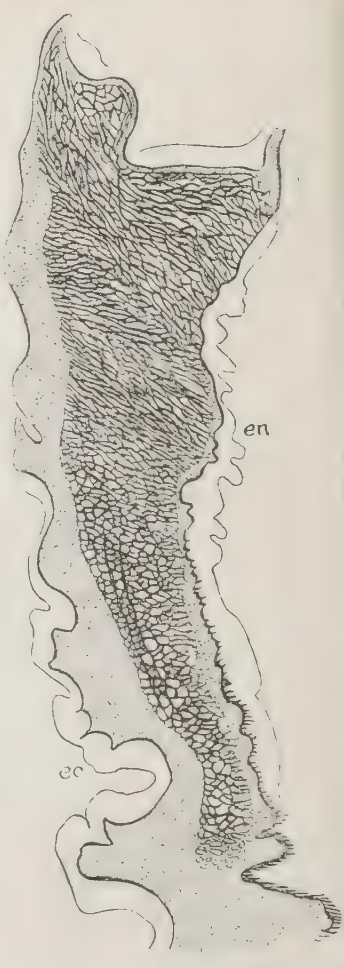

FIG. 2.—LONGITUDINAL SECTION OF COLUMN WALL OF *Sagartia paguri*, SHOWING SPHINCTER MUSCLES. *ec*, ECTODERM. *en*, ENDODERM.

The habits of this form suggest its reference to the genus *Adamsia*, but the arrangement of the mesenteries clearly indicates it as a member of the Sagartiinæ, and it is to be assigned to the genus *Sagartia*.

ON A SMALL COLLECTION OF CRUSTACEANS FROM THE ISLAND OF CUBA.

By William Perry Hay,
Of Howard University, Washington City.

In the early spring of 1902, Dr. C. H. Eigenmann, of the State University of Indiana, visited the island of Cuba for the purpose of collecting specimens of blind fish and other forms of life known to inhabit certain limestone caverns of that region. The successful result of the exploration, so far as the fish were concerned, has already been reported at the Pittsburg meeting of the American Association for the Advancement of Science, which organization had by a grant of money helped to defray Dr. Eigenmann's expenses, but so far as I know no report has hitherto been made on the miscellaneous collections.

The collection of crustaceans, which is contained in 25 jars and vials, includes 14 species. They were collected at various points along the seashore, in fresh-water streams, and in the caverns. Most of the species are well known and have been reported from the island: all are mentioned here, however, for the sake of completeness. Of the three new species, two belong to the subterranean fauna and are of especial interest in that they are the first spelæan crustaceans to be recorded from Cuba and belong to genera which until very recently have not been suspected of adapting themselves to a subterranean life.

In the identification of the shrimps and the Brachyura I have enjoyed the benefit of the extensive knowledge of these groups of Miss Mary J. Rathbun, without whose assistance this paper would have been considerably delayed.

In the case of all new species Dr. Eigenmann has allowed me to deposit the types in the collection of the U. S. National Museum while the cotypes are in the collection of the University of Indiana.

LIST OF SPECIES.

ORDER ISOPODA.

1. *Cirolana cubensis*, new species.
2. *Oniscus asellus* Linnæus.

ORDER DECAPODA.

MACRURA.

3. *Palæmonetes eigenmanni*, new species.
4. *Palæmonetes cubensis*, new species.
5. *Bithynis jamaicensis* (Herbst).
6. *Bithynis olfersii* (Wiegmann).
7. *Bithynis acanthurus* (Wiegmann).
8. *Xiphocaris elongata* (Guérin)
9. *Penæus brasiliensis* Latreille.
10. *Cambarus cubensis* Saussure.

BRACHYURA.

11. *Callinectes sapidus acutidens* Rathbun.
12. *Epilobocera cubensis* Stimpson.
13. *Goniopsis cruentata* (Latreille).
14. *Ucides cordatus* (Linnæus).

1. CIROLANA CUBENSIS, new species.

Types.—Cat. No. 26348, U.S.N.M. Cavern at San Isidro, Cuba. C. H. Eigenmann, Col., 1902.

Body oval, a little more than twice as long as broad, widest a little behind the middle, rather strongly convex, and perfectly smooth. Head a little broader than long, slightly produced in front. Mesosome broader, with its greatest width at the fifth segment; coxal plates of the second, third, fourth, fifth, and sixth segments successively more enlarged and more strongly produced backward as an acute angle. The plate of the seventh segment is about the same size as the one preceding it. Metasome narrower than mesosome, of five segments, each of which, except the last, has the lateral angles strongly produced posteriorly; telson as long as the metasome, its margins gently curved and convergent for about two-thirds of its length, and then rather abruptly strongly convergent to form a short, obtuse tip. The eyes are altogether wanting. First antenna with three basal segments and a short flagellum which, when extended backward, reaches slightly beyond the posterior margin of the first thoracic segment. Second antenna with five basal segments, and a long, slender flagel-

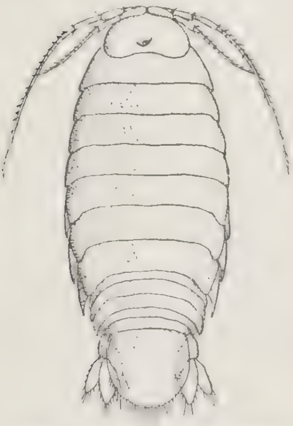

FIG. 1.—CIROLANA CUBENSIS.

lum which may extend slightly beyond the middle of the body, and is composed of about twenty-nine segments. The mandible, maxillæ, and maxillipeds do not present specific characters of importance, being of the type usual in the genus. The appendages of the mesosome are of moderate strength, and are armed with a few rather stout spines and stiff setæ. The branchial appendages of the metasome are membranaceous and small; the uropoda are well developed, the outer branch lanceolate in outline, the inner much broader and very slightly longer, and with the tip somewhat acuminate; both branches and the margins of the telson as well bear a rather dense fringe of hairs. Color in alcohol, white, with no markings of any kind. Length, 5 mm.

This Isopod, which is reported by Dr. Eigenmann to be abundant, is represented in the collection by about twenty-five specimens, all from the one locality. Of the species of *Cirolana* known to inhabit American waters, *C. mayana*, which occurs on the coast of Yucatan and Colombia, is the nearest relative of the present species. Between the two, however, there are several important structural differences. The physiological differences between this species and all the others of the genus must be very great to admit of its living in the subterranean streams of fresh water. It may be added that *Cirolana cubensis* is very distinct from *Cirolanides texensis* Benedict,[a] which occurs in the waters which flow from the large artesian well at San Marcos, Texas.

2. ONISCUS ASELLUS Linnæus.

Five specimens, for which no locality is given, appear to belong here. They answer perfectly the description given by Sars[b] from specimens collected in Norway. They are doubtless importations from Europe, and probably came from Spain, where the species is common.

3. PALÆMONETES EIGENMANNI, new species.

Types.—Cat. No. 26349, U.S.N.M. Cavern at Ashton, Cuba. C. H. Eigenmann.

Carapace thin, very delicate and transparent, in form slightly compressed near the middle of the body but rather broad anteriorly; the anterior border, below the eye, is produced as a broad, obtuse angle, which bears, near its lower margin, an acute, forwardly directed spine; this spine is the anterior end of an obscurely marked ridge, which extends obliquely downward and backward along the sides of the carapace. The rostrum is long, slender, compressed, and rather markedly upcurved; on its superior margin it bears a row of six or eight slender, acute teeth, which begins well back on the carapace and extends forward to the rostrum; these teeth are directed

[a] Benedict, Proc. U. S. Nat. Mus., XVIII, 1896, p. 616.
[b] Crust. Norway, II, Pts. 9, 10, 1897, pp. 171, 172.

obliquely forward; the inferior margin is unarmed; the tip of the rostrum is acute and reaches forward to a point opposite the distal extremities of the antennal scales. The eyes are much reduced in size, are without pigment, and the corneal surface comes to an obtuse point in front. The first antenna has the basal segment well excavated above and provided with a small, acute spine at the outer distal angle; there are two long and one short flagella, the short one slightly exceeding the rostrum, the long ones somewhat longer than the body. The second antenna has the basal segment provided with a small spine near the distal end; the antennal scale is broad and with subparallel margins; the tip is slightly rounded, and there is a small, obtuse spine at the outer distal angle; the flagellum is slender, and about twice as long as the body. The mandible has an incisor portion with three or four sharp teeth, a small molar surface with several obtuse teeth, but is without a palpus. The third maxilliped is not strongly developed and presents no characters of importance. The

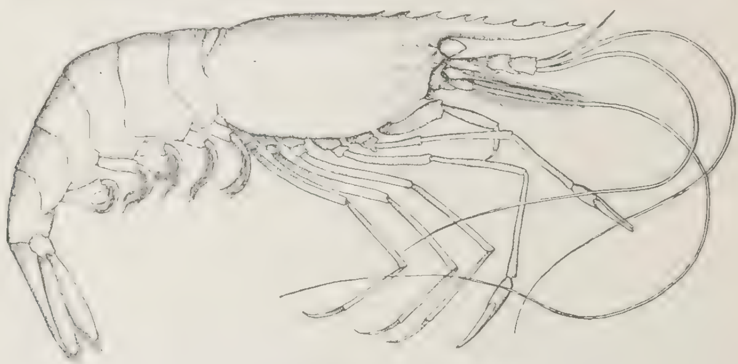

FIG. 2.—PALÆMONETES EIGENMANNI.

first pair of pereiopods is chelate, and except for its much smaller size is exactly like the second; the chela is slender and weak; the carpal segment is long and slender; the meros is of about the same length, but stouter; the remaining segments short and rather thick. The remaining pereiopods are very long and slender. The abdomen is of the form usual in this genus, but the sixth segment is neither elongate nor compressed; the telson narrows gradually from the base to the obtusely angulate tip; on the upper surface there is on each side at about the middle and again about one-fourth the distance from the tip a small, appressed spine, at the tip there is on each side one minute and one long, slender spine, and in the middle a fringe of setæ. Color in alcohol, white. Length, 23 mm.

Nine specimens of this interesting shrimp were sent to me, three from Ashton, two from Modesta, one from the cave of Jaiguan, and three from the cave at San Isidro. Dr. Eigenmann reports that they were common.

They differ very markedly from *Palæmonetes antrorum* Benedict, hitherto our only known blind *Palæmonetes*, in the shape of the rostrum and the character of the chelæ. The shape of the eye is rather remarkable, even in a group, where through atrophy the eye tends toward the conical form. I know of no other in which it is produced into a blunt point. So far as I have been able to ascertain, this is the first record for this genus in Cuba. In the material from San Isidro there is one specimen which agrees in every way with the types, but the other two differ in such a manner as to lead me to believe that a second species may be found to inhabit the subterranean waters of Cuba. The two specimens just mentioned have the sixth segment of the abdomen two and one-half times as long as deep, and the antennal scale is more slender and acute. Unfortunately, the rostrum of one is entirely gone, while of the other only the abdomen remains.

4. PALÆMONETES CUBENSIS, new species.

Types.—Cat. No. 26350, U.S.N.M. Palacio, Cuba. C. H. Eigenmann Col., 1902.

Carapace of the character usual in this genus, rounded above, slightly compressed, and prolonged in front into a large, upcurved, serrated rostrum; at the anterior margin, a short distance below the eye, there is a minute incurved spine, and below it, slightly back of the margin, a second larger spine. The rostrum is longer than the carapace, strongly compressed and serrate above and below; the tip is somewhat upcurved and the base is usually inclined slightly downward toward the middle, but often the basal half is in line with the top of the carapace; the teeth on the upper margin of the rostrum number seven or eight, five or six being disposed with some regularity from the base to a point anterior to the middle; there is then a toothless space which is followed by two small teeth close together at the tip; on the lower surface there are about five teeth, the most posterior one being the largest and placed just in advance of the eye.

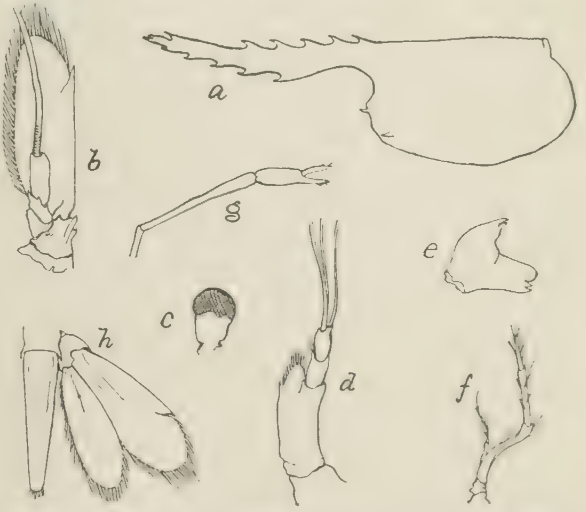

Fig. 3.—Palæmonetes cubensis. *a*, Carapace. *b*, Second antenna. *c*, Eye. *d*, First antenna. *e*, Mandible. *f*, Third maxilliped. *g*, First chelate appendage. *h*, Teeson and sixth abdominal appendage.

The eyes are large and abundantly supplied with pigment. The first antennæ have the basal segment strongly excavated, while the outer margin is expanded into a plate-like process which bears just back of the rounded tip, a small spine; the three flagella are slender. The second antennæ are very slender and exceed the body in length; the scale is broad and long, but does not exceed the rostrum; there is a small spine on the outer face of the basal segment and another on the outer margin of the scale near its tip. The mandible does not bear a palpus, the incisor portion is provided with two or three sharp teeth, while the molar surface has three somewhat obtuse ridges. The third maxillipeds are pediform as usual, but are small. The second pair of pereiopods are chelate like the first pair and exceed them slightly in size; the carpus is longer than the hand and the fingers are shorter than the palm. The telson narrows uniformly from the base to the small rounded tip, which bears five small spines. Color in alcohol yellowish; length, 30 mm. Eighteen specimens were collected from the following localities: Palacio, 8; Pinar del Rio, 7; San Cristobal, 3.

5. BITHYNIS JAMAICENSIS (Herbst).

Represented by one large specimen from Calabazar.

6. BITHYNIS OLFERSII (Wiegmann).

Represented by specimens from Calabazar (3), Pinar del Rio (4), San Juan (4), and El Sumidero (7).

7. BITHYNIS ACANTHURUS (Wiegmann).

Seven specimens of this shrimp were collected near San Juan.

8. XIPHOCARIS ELONGATA (Guérin).

A series of seven specimens labeled "Calabazar" represent this species.

9. PENÆUS BRASILIENSIS Latreille.

Two specimens from San Juan.

10. CAMBARUS CUBENSIS Erichson.

Two specimens, male and female. No locality given.

These specimens differ considerably from individuals from other localities and may represent an undescribed form. The abdominal appendages of the male and the annulus ventralis of the female are those of *C. cubensis*, but there is a well-developed spine on the side of the carapace, the areola is much narrower than usual (seven times as long as wide), the margins of the rostrum are raised into high, sharp ridges, the lateral teeth of the rostrum are well developed, and the acumen is slender.

11. CALLINECTES SAPIDUS ACUTIDENS Rathbun.

Five specimens as follows: Mouth of Yumuri[a] (2), Pinar del Rio (1 large male), San Juan (1 female), unknown locality (1 small male).

12. EPILOBOCERA CUBENSIS Stimpson.

A small series of two males, one female, and one young from Ashton and one young from Modesta represent this species.

13. GONIOPSIS CRUENTATA (Latreille.)

Two specimens from the mouth of the Yumuri River, a male and a female. The male is the larger and more brilliantly colored. The female carries a large mass of eggs.

14. UCIDES CORDATUS (Linnæus).

Two specimens (male and female) from the mouth of the Yumuri River. The male has recently suffered the loss of two of his legs and is beginning to reproduce them. They now consist of buds about one-half an inch long in which five segments can be distinguished, but the last three are bound down tightly against the other two and inclosed with them in a chitinous envelope. If the limb is removed from this capsule and extended it is about 25 millimeters in length.

To what extent this method of reproduction obtains among the crustacea I am unable to say, but I have observed it in several species of Brachyurans. In the Macrura, on the other hand, in the few cases which I have observed, the new limb appears as a bud in which the segments are extended as in the fully developed appendage.

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[a]The following note has been supplied by Dr. Eigenmann: El Sumidero is a river running in part underground west of Pinar del Rio. The Yumuri River is a stream emptying into the ocean at Matanzas.

MAMMALS COLLECTED BY DR. W. L. ABBOTT ON THE COAST AND ISLANDS OF NORTHWEST SUMATRA.

By Gerrit S. Miller, Jr.

Assistant Curator, Division of Mammals.

The period from November, 1901, to April, 1902, was spent by Dr. W. L. Abbott in exploration of the coast and islands of northwestern Sumatra. As a result of this work large and exceedingly valuable collections were obtained, all of which have been presented to the United States National Museum. This paper contains an account of the mammals, numbering 492 specimens.

ITINERARY AND DESCRIPTION OF LOCALITIES.

Leaving Singapore about the middle of October, Dr. Abbott sailed northward through the Strait of Malacca. His first collecting station was at Loh Sidoh Bay, on the west coast of Sumatra, a few miles south of Acheen Head, the extreme northwestern point of the island. Only four days, November 5 to 8, were spent at this locality, which, to judge by the remarks in the collector's field book, is a moderately hilly region abounding in dense jungle and in cocoanut plantations. Dr. Abbott says of this locality:

It was probably a pretty good place for collecting, but one dare not go far off, and the natives stole my traps. There was a Dutch patrol there, but the sergeant in charge said it was anything but safe.

The next locality visited was the large island forming the northern end of the archipelago off the west coast of Sumatra. It is variously known as Pulo Simalur, Pulo Simaloe, Pulo Si Malu, Pulo Babie, and Hog Island. The first of these names is the one adopted by Dr. Abbott. This island is about 55 miles in length and is moderately high and hilly. Its surface is well wooded. Here about six weeks (November 16, 1901, to January 2, 1902) were spent. Mammals were collected at several localities on the island: Telok Dalam, at about middle of east coast (November 18 to 28); Sibabo Bay, a short distance north of Telok Dalam (December 10 to 17); Sigoeli River, near north end of island (December 19); Pulo Siumat (December 27 to 30), and Labuan Badjan Bay (January 1, 1902), at southern extremity. Pulo

Simnat lies about 5 miles off the eastern coast of Simalur, about halfway between Telok Dalam and Labuan Badjan Bay. It contains about 1,000 acres and is mostly cleared and planted with cocoanuts, etc.

Two small islands, the Tapak or Flat Islands, about 15 miles from the southeastern extremity of Simalur, were next explored (January 4 to 9). Pulo Lasia (pronounced Lahseea), the more northerly and also the smaller, is an uninhabited mass of coral rock covered with dense forest. It is about 2½ miles long and 2 miles wide. Separated from Pulo Lasia by a strait a mile and a half wide is Pulo Babi, a slightly larger island, also of coral rock, but with more sand and soil than there is on Lasia. Like the smaller island, it is uninhabited, though the forest contains some cocoanut palms, and pigs are very abundant.

Nineteen miles east of Pulo Babi and 31 miles north of Nias lies Pulo Bangkaru, the most westerly and second largest of the Banjak or Banyak (many) Islands, the group next visited (January 16 to February 6). The surface is irregular and heavily forested, its highest point probably rising 1,000 feet above the sea. The island covers an area of about 20 square miles. A week was spent here at an anchorage in Cameleon Bay on the southeast coast. Great Banjak Island, Pulo Tuangku, or Tunanku (spelled Toeankoe on the Dutch charts), is 6 miles east of Pulo Bangkaru and 25 from Singkel, the nearest point in Sumatra. It is about 17 miles long by 5 wide and probably contains 40 or 50 square miles. The highest points are Bukit Teressa, a cone-shaped hill about 1,000 feet in altitude, and Batu Lauteh, which rises to about 800 feet. Both are situated at the north end of the island, where are also the few clearings and paddy fields. Cultivation on any extended scale is prevented by the abundance of pigs and monkeys, but on the islets off the coast cocoanuts are successfully grown.

From the Banjak Islands Dr. Abbott crossed to Tapanuli (or Tappanoeli) Bay on the west coast of Sumatra. Here he spent the last half of February and the month of March, partly at points on the mainland and partly (March 2 to 14) at Pulo Mansalar (also spelled Moesalla, Massalla, Mansalla, and Mensilla), at the entrance to the bay. The principal collecting stations were Tapanuli and Siboga settlements, near the north end of the bay, Jaga Jaga, a stream near the south end, Butik Kebong and Butik Sawa, hills 1,224 and 1,100 feet in height, respectively, lying near the coast just south of the Jaga Jaga, Lobo Pandan Bay, at the south foot of Butik Kebong, and Gunong Panjamurong Udong, a hill on the south side of Lobo Pandan Bay. The country throughout this region is fertile and well forested. Pulo Mansalar, at the mouth of Tapanuli Bay, is 7 miles from the mainland. It is 11 miles long and contains 45 square miles. The heavily forested surface is mountainous, with scarcely any level ground, though the highest point is only 1,660 feet above sea level. The timber is very fine, and much is cut and taken to Siboga for house building.

SYSTEMATIC LIST OF SPECIES.

Family TRAGULIDÆ.

TRAGULUS NAPU (F. Cuvier).

1822. *Moschus napu* F. Cuvier, Hist. Nat. des Mammifères, IV, Pt. 37, [p. 108], November, 1822; Sumatra.

An adult male and three immature specimens were taken at Tapanuli Bay. (For measurements see table, page 442.) These are the first representatives of the species received by the United States National Museum. In all respects they agree with those recently recorded by Stone and Rehn[a] from the Lampong district.[b] *Tragulus napu* proves to be a grayish animal quite distinct from *T. pretiosus* and *T. nigricollis*, but somewhat closely resembling *T. canescens* of the Malay Peninsula. The general appearance is well indicated by the larger figure on Cuvier's plate.

TRAGULUS AMŒNUS, new species.

Type.—Adult male (skin and skull), Cat. No. 114563, U.S.N.M. Collected on Pulo Mansalar, off Tapanuli Bay, Sumatra, March 8, 1902, by Dr. W. L. Abbott. Original number, 1632.

Characters.—A yellowish, dark-necked member of the *napu* group, somewhat closely resembling *Tragulus nigricollis*[c] of Sinkep Island, but smaller and more richly colored. Throat pattern normal, the dark stripes blackish.

Color.—Type: Upperparts orange ochraceous, darkening toward ochraceous rufous on outer surface of legs, and lightening to a buff considerably yellower than that of Ridgway on sides, the hairs everywhere pale ecrudrab at extreme base and black at tip. The black tips produce a heavy shading on both back and sides. On the former it is slightly in excess of the orange ochraceous, but on sides the two colors, as seen in the skin, are about equally mixed. Throughout, the grizzle caused by the contrasting colors is more coarse and conspicuous than in *Tragulus pretiosus*, a difference which may prove to be seasonal. Neck mostly black, this color clear and unmarked immediately behind occiput, but elsewhere speckled with dull tawny ochraceous. At sides this speckling is rather conspicuous, but on dorsal surface it is not very noticeable except posteriorly. Crown black, slightly speckled with dull tawny ochraceous anteriorly. Cheeks and the usual superciliary stripe dull tawny ochraceous, slightly grizzled with black. Throat markings normal, the dark bands black, slightly speckled with tawny ochraceous:

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[a] Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 127, June 4, 1902.

[b] For the opportunity to examine the Lampong material I am indebted to the kindness of Mr. Witmer Stone and the authorities of the Philadelphia Academy of Natural Sciences.

[c] Miller, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 145, June 11, 1902.

the light stripes pure white. Collar broad and distinct, concolor with sides of body. Underparts and stripe down inner surface of legs white, a narrow brownish longitudinal line along middle of chest, and a faint buffy suffusion on middle of belly. Tail lacking in the type. In an immature female it is similar to back above, but duller and less washed with black, pure white below and at tip.

Skull and teeth. The skull and teeth are rather smaller than in *Tragulus napu* and *T. nigricollis*, about equaling those of *T. pretiosus*. In form they show no peculiarities worthy of note, though the skull is relatively broader than in the Sumatran animal.

Measurements.[a]—External measurements of type: Head and body, 520; hind foot, 129 (115); ear from meatus, 32; ear from crown, 27; weight, 2.7 kilograms.

Cranial measurements of type: Greatest length, 108.6 (116);[b] basal length, 101.4 (108); basilar length, 96 (99); occipito-nasal length, 98 (104); length of nasals, 33 (32); greatest breadth of both nasals together, 13 (13.4); diastema, 11 (10.6); zygomatic breadth, 47 (47); least interorbital breadth, 31.4 (31.4); mandible, 86 (88); maxillary tooth row (alveoli), 35 (37); maxillary premolars (crowns), 18.4 (18.4); mandibular tooth row (alveoli), 42 (42); mandibular premolars (crowns), 19 (19).

Specimens examined.—Two, both from Pulo Mansalar.

Remarks. While *Tragulus amœnus* is very different from the grayish *T. napu* of the near-by mainland, it rather closely resembles the yellowish *T. pretiosus* and *T. nigricollis* from Linga and Sinkep islands off the east coast of Sumatra. The details of its characters, however, readily distinguish it from both of these.

TRAGULUS JUGULARIS, new species.

Type.—Adult male (skin and skull), Cat. No. 114574, U.S.N.M. Collected on Pulo Mansalar, off Tapanuli Bay, Sumatra, March 8, 1902, by Dr. W. L. Abbott. Original number, 1627.

Characters.—Size about as in *Tragulus amœnus.* No white anywhere. Apparently rather closely resembling *Tragulus annæ* Matschie,[c] but ear smaller, and dark loral stripe and light bands on throat clearly indicated.

Color.—Type: With the exception of the under parts, inner surface of legs, and under surface of tail, the color is almost exactly as in the type of *Tragulus amœnus.* The neck, however, is less speckled with tawny ochraceous, and the cheeks and superciliary stripes are somewhat more washed with black. This wash is not enough to obscure

[a] The measurements in this paper are all in millimeters.

[b] Measurements in parentheses are those of an adult male *Tragulus napu* from Tapanuli Bay, Sumatra (No. 114434).

[c] Sitz-Ber. Gesellsch. naturforsch. Freunde zu Berlin, 1897, p. 157.

the strong contrast between the superciliary stripes and the black, very obscurely grizzled crown. Inner surface of legs, under surface of tail, and entire ventral surface behind throat markings orange buff, brighter on legs and middle of chest, duller on tail, and paler and more gray in axillary and hypogastric regions; middle of belly with a distinct dusky wash. The portion of chin normally white is concolor with cheeks, and the light throat stripes are merely indicated by a stronger grizzle of tawny ochraceous in the general black of the throat. This indication, however, is so distinct that it can not be overlooked, and in many specimens it is even more evident than in the type. In none of the 17 examined is it absent. The pattern thus outlined is in every respect normal. Collar of normal extent, but rather more tawny than in *Tragulus amœnus*. Ears, naked area around and in front of eyes, feet, and lower half of tarsus and carpus covered with minute blackish hairs.

The series is very uniform in color. Some variation is shown in the distinctness with which the throat markings are indicated, and in the amount of dusky wash on the belly. In many skins the blackish hairs on feet and distal portion of legs are mostly replaced by tawny, but in general the dusky feet are characteristic. None shows distinct white on any part of the body.

Skull and teeth.—While the skull is smaller than that of *Tragulus napu*, I can see nothing to distinguish it from that of *T. amœnus*, with which it agrees in both size and form. The teeth, on the other hand, particularly the premolars, are distinctly larger than in the related species.

Measurements.—External measurements of type: Total length, 578; head and body, 513; tail vertebræ, 65; hind foot, 130 (114); ear from meatus, 28; ear from crown, 25; weight, 2.4 kilograms. Average of five adult males from the type locality: Total length, 587 (575–618); head and body, 514 (505–538); tail vertebræ, 72.6 (65–80); hind foot, 130.2 (126–133); hind foot without hoofs, 115.4 (111–119). Average of ten adult females from the type locality: Total length, 610 (570–670); head and body, 536 (495–590); tail vertebræ, 74.2 (65–80); hind foot, 132.9 (128–138); hind foot without hoofs, 118.5 (111–124). For details see table, p. 442.

Cranial measurements of type: Greatest length, 106; basal length, 99; basilar length, 92; occipito-nasal length, 97; length of nasals, 28.6; greatest breadth of both nasals together, 13; diastema, 8.8; zygomatic breadth, 45; least interorbital breadth, 29; mandible, 85; maxillary tooth row (alveoli), 38.6; maxillary premolars (crowns), 20; mandibular tooth row (alveoli), 45; mandibular premolars (crowns), 20.6.

Specimens examined.—Seventeen, all from Pulo Mansalar.

Remarks.—The only species with which this animal needs comparison is the *Tragulus annæ*, described by Matschie from specimens from an

unknown locality. The main points of difference are as follows: In *Tragulus anna* there is no trace of the pale throat markings[a] or of the black loral stripe,[b] all of which are present in *T. jugularis;* the length of ear is stated to be 37 mm., while in none of the specimens of *T. jugularis* does this measurement, taken with the greatest possible amplitude, exceed 32 mm.

Measurements of Tragulus of the Napu group.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail vertebræ.	Hind foot.	Hind foot without hoofs.
				mm.	*mm.*	*mm.*	*mm.*	*mm.*
Tragulus napu	Tapanuli Bay	114432	Male young	560	480	80	135	120
Do	do	114433	do	425	370	55	120	107
Do	do	114434	Male adult	620	550	70	147	130
Do	do	114435	Male young	530	470	60	135	121
Tragulus amœnus	Pulo Mansalar	141562	Female young	498	433	65	119	117
Do	do	[a]114563	Male adult	....	520	......	129	115
Tragulus jugularis	do	114564	Female adult.	590	515	75	128	111
Do	do	114565	Female young	560	480	80	131	115
Do	do	114566	Female adult.	595	515	80	135	120
Do	do	114567	do	597	532	65	130	117
Do	do	114568	do	570	495	75	132	118
Do	do	114569	do	580	500	80	138	123
Do	do	114573	do	670	590	80	133	120
Do	do	114576	do	[b]558	540	[b]18	133	118
Do	do	114577	do	650	580	70	130	115
Do	do	114579	do	628	558	70	137	124
Do	do	114580	do	608	533	73	133	119
Do	do	114570	Male adult	585	510	75	133	119
Do	do	114571	do	578	505	73	129	115
Do	do	114572	Male young	515	450	65	118	104
Do	do	[a]114574	Male adult	578	513	65	130	114
Do	do	114575	do	618	538	80	133	118
Do	do	114578	do	575	505	70	126	111

[a] Type. [b] Tail imperfect.

TRAGULUS KANCHIL (Raffles).

1822. *Maschus kanchil* RAFFLES, Trans. Linn. Soc. London, XIII, p. 262; Bencoolen, Sumatra.

1902. *Tragulus kanchil* STONE and REHN, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 128, June 4, 1902.

Twelve specimens were taken at Tapanuli Bay, Sumatra. For measurements, see table, page 446. In nine of these the diagonal dark throat stripes are united anteriorly, while in three they are separated by the forward prolongation of the median white stripe. The series is very uniform in both size and coloration, and none of the specimens show any approach toward the peculiarities of the forms inhabiting the Banjak Islands.

[a] Die Halsgegend ist ringsherum tief schwarzbraun und zeigt keine Spur von hellen Binden an der Vorderseite und an der Oberbrust.

[b] Vom Auge zur Nase ist ein dunkler Streif nicht wahrnehmbar, sondern der Kopf ist ebenso gefärbt wie der Rücken und nur über den Augen und auf der Oberlippe ist ein heller Strich angedeutet.

TRAGULUS BREVIPES, new species.

Type.—Adult female (skin and skull). Cat. No. 114326, U.S.N.M. Collected on Pulo Bangkaru, Banjak Islands, January 20, 1902, by Dr. W. L. Abbott. Original number, 1443.

Characters.—General size as in *Tragulus kanchil*, but ears and feet much shorter. Coloration slightly paler than in the Sumatran animal, but of exactly the same type. Skull with rostral portion more slender than in the related species.

Color.—Back a fine grizzle of black and light orange-buff, the former slightly in excess. Sides buff-yellow, a little clouded by the black hair-tips. Outer surface of legs bright orange-buff, the hairs of the front legs with faintly indicated black tips, those of the hind legs rather strongly shaded with black. Nape-stripe clear black, sharply contrasted with the dull, slightly grizzled, orange-buff sides of neck. Crown blackish, the hairs very obscurely annulated with dull yellowish brown. Cheek from below outer canthus of eye to muzzle dirty cream color, in rather strong contrast with surrounding parts. Under parts and inner surface of legs white. Median line of chest with a narrow, grizzled brown stripe, and middle of belly with an obscure buffy wash. Throat pattern normal, the brown stripes strongly grizzled and considerably darker than sides of neck, confluent in front. Collar narrow but well defined, concolor with sides of neck. Tail clear, dull, orange-buff above, pure white below and at tip.

Skull and teeth.—In size and general form the skull closely resembles that of *Tragulus kanchil* and *T. russeus*, but the rostrum is distinctly narrower than in any of the specimens of the related species—a difference easily appreciable on comparison. Teeth as in *Tragulus kanchil*.

Measurements.—External measurements of type: Total length, 520; head and body, 450; tail vertebræ, 70; hind foot, 108 (98).

Cranial measurements of type: Greatest length, 97 (95);[a] basal length, 90 (89); basilar length, 85 (83); diastema, 11.4 (10.4); length of nasals, 29.6 (28); greatest breadth of nasals posteriorly, 12 (12.6); least interorbital breadth, 26 (28); breadth of palate at middle of diastema, 11 (13.6); zygomatic breadth, 42 (42); mandible, 77 (73); maxillary tooth row (alveoli), 34 (32.6); mandibular tooth row (alveoli), 41.4 (35).

Specimens examined.—One, the type.

Remarks.—In its small feet and pale color *Tragulus brevipes* suggests *T. pallidus*, but the latter is a much more pallid animal and its skull has an exceedingly short, heavy rostrum.

[a] Measurements in parenthesis are those of an adult female *Tragulus kanchil* from Tapanuli Bay, Sumatra (No. 114421).

TRAGULUS RUSSEUS, new species.

Type.—Adult male (skin and skull), Cat. No. 114337, U.S.N.M. Collected on Pulo Tuangku, Banjak Islands, February 15, 1902, by Dr. W. L. Abbott. Original number, 1518.

Characters.—Size and general appearance as in *Tragulus fulviventer* (Gray,[a] but brown throat stripes not as dark and white stripes often obsolete and occasionally absent.

Color.—Type: General color above orange-ochraceous, slightly paler on sides and darkening to raw sienna on neck and outer surface of limbs. The hairs of the back are tipped with black, which, when the fur is undisturbed, forms a dark shading decidedly in excess of the orange-ochraceous. Across shoulders this shading deepens rapidly into the clear black nape stripe. On sides of body and neck the lighter color is in excess of the black, which practically disappears along lower edge of sides, where the color passes into the clear raw sienna of legs and very pale orange-ochraceous with which the under parts are suffused. Crown blackish, strongly grizzled with yellowish brown. Cheeks distinctly paler than neck, the exact color intermediate between the buff-yellow and straw-yellow of Ridgway. Muzzle darker and duller than cheeks. An indistinct pale line borders dark color of crown from ear to muzzle. Ears blackish. Chest and belly pale orange-ochraceous, fading nearly to ochraceous buff in axillary region, and with white markings as follows: (1) A large patch in hypogastric region, continued downward along inner side of hind legs and forward as two narrow stripes to about level of diaphragm; and (2) a narrow stripe on each side of median line of chest. Chin white to about 10 mm. behind median bare area, the posterior outline of the white nearly straight, and 55 mm. in length. Behind this the region usually occupied by the white throat stripes presents a peculiar mottled aspect, due to the fact that the white is mostly replaced by clear orange-ochraceous, which forms no distinct contrast with the collar and dark stripes, both of which are essentially like sides of neck, therefore distinctly grizzled. The white persists as a semilunar spot 20 mm. wide by 10 mm. long (the concavity directed backward), the remnant of the posterior extremity of the median stripe, and a very faint, easily overlooked trace of each of the lateral stripes. The collar sends back a dark median stripe 90 mm. in length between the two white chest stripes. Inner surface of front leg with a few whitish hairs, not enough to produce a white area. Tail white beneath and at tip, concolor with flanks above.

While the type represents the more extreme phase of the species, one specimen (female Cat. No. 114336, U. S. N. M., original number 1507), carries the peculiarities much further. In this the white is all replaced

[a] See Stone and Rehn, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 131, June 4, 1902.

by orange-ochraceous except a very narrow line along under surface of tail, and two faint traces 20 mm. in length on middle of chest. In the majority of specimens the under parts are as in the type, except that the white areas are slightly more extended and the throat markings are normal in extent and pattern. The dark throat stripes, however, are never as dark as those of *T. kanchil* or as those of the specimen described as *T. fulviventer* by Stone and Rehn.

Skull and teeth.—Except that they are larger throughout, the skull and teeth are essentially as in the *Tragulus fulviventer* of Stone and Rehn.

Measurements.—External measurements of type: Total length, 505 (440);[a] head and body, 455 (400); tail vertebræ, 60 (40); hind foot, 120 (113); hind foot without hoofs, 110 (103); ear from meatus, 29 ( ); ear from crown, 22 (15). Average of eight males from the type locality: Total length, 531 (505–563); head and body, 467 (450–493); tail vertebræ, 65 (55–70); hind foot, 120.3 (116–125); hind foot without hoofs, 107.9 (104–113). Average of four females from the type locality: Total length, 525 (500–540); head and body, 458 (435–470); tail vertebræ, 68.8 (65–70); hind foot, 118.8 (117–120); hind foot without hoofs, 107.3 (106–109). For details see table, page 446.

Cranial measurements of type: Greatest length, 99 ( );[a] length from inion to tip of premaxillaries, 97 (86); basal length, 91 ( ); basilar length, 85 (–); length of nasals, 31.4 (24); diastema, 8 (7); zygomatic breadth, 45 (41); least interorbital breadth, 28 (25); width of palate between anterior molars, 17.8 (16.4); front of orbit to tip of premaxillary, 44.4 (41.6); mandible, 78 (73); maxillary toothrow (alveoli), 35 (32); mandibular toothrow (alveoli), 41 (37).

Specimens examined.—Fifteen, all from Pulo Tuangku.

Remarks.—This species is readily distinguishable from *Tragulus kanchil* by its smaller size, brighter, more fulvous color, the greater extension of the fulvous wash on belly and chest, and the character of the throat markings. It is evidently more closely related to *Tragulus fulviventer.* With this animal it agrees in size and in the general type of coloration, but differs in the very light color of the brown throat markings and the tendency of the white stripes to become obsolete, in the latter peculiarity showing an interesting parallelism with *Tragulus jugularis* of Pulo Mansalar. Of *Tragulus fulviventer* I have examined the specimen described by Stone and Rehn, and Mr. Oldfield Thomas has sent the following measurements of Gray's type, an adult female in the British Museum: Head and body (skin), 450; hind foot with hoof, 122; basal length of skull, 84; palatal length, 59; interorbital breadth, 24.5; combined length of three upper premolars, 18.5; combined length of three lower premolars, 18.5.

[a] Measurements in parentheses are those of the specimen *Tragulus fulviventer* of Stone and Rehn, male adult, No. 642, Philadelphia Academy of Sciences.

Measurements of Tragulus of the kanchil group.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail vertebræ.	Hind foot.	Hind foot without hoofs.
				mm.	*mm.*	*mm.*	*mm.*	*mm.*
Tragulus kanchil	Tapanuli Bay	114417	Male adult	503	433	70	123	111
Do	do	114418	do	520	440	80	127	115
Do	do	114419	do	507	432	75	118	107
Do	do	114420	do	537	442	95	128	115
Do	do	114426	do	485	425	60	121	108
Do	do	114427	do	500	430	70	124	111
Do	do	114421	Female adult	548	468	80	128	115
Do	do	114422	do	537	457	80	128	114
Do	do	114423	do	545	470	75	120	108
Do	do	114424	do	535	465	70	121	109
Do	do	114425	do	520	450	70	125	113
Do	do	114428	do	495	430	65	121	108
Tragulus brevipes	Pulo Bangkaru	114326	do	520	450	70	109	98
Tragulus russeus	Pulo Tuangku	114328	Male adult	[b] 510	480	[b] 30	118	104
Do	do	114329	do	563	493	70	122	110
Do	do	114331	do	520	455	65	123	110
Do	do	114333	do	540	470	70	120	107
Do	do	[a] 114337	do	515	455	60	116	104
Do	do	114339	do	[c] 520	[c] 445	[c] 65	118	107
Do	do	114340	do	555	485	70	125	113
Do	do	114341	Male young	500	430	70	110	98
Do	do	114342	Male adult	505	450	55	120	108
Do	do	114330	Female adult	540	470	70	119	107
Do	do	114332	do	520	455	65	120	109
Do	do	114334	Female young	382	327	55	100	89
Do	do	114335	do	500	435	65	110	98
Do	do	114336	Female adult	500	435	70	117	106
Do	do	114338	do	540	470	70	119	107

[a] Type. [b] Tail imperfect. [c] Estimated from dry skin.

Family SUIDÆ.

SUS VITTATUS Müller and Schlegel.

1839–1844. *Sus vittatus* Müller and Schlegel, Verhandel. over de natuurlijke Geschiedenis der Nederl. overzeesche bezittingen, p. 173; Java.

Nine specimens (skins with skulls) as follows: Simalur Island, 4; Pulo Babi, 3; Pulo Tuangku, 2. For measurements see table, p. 446.

It is possible that more than one form is represented by this series. The pig of Simalur Island is considerably smaller than that of Pulo Babi; and that of Pulo Tuangku, judged by the skulls rather than by the external measurements, is intermediate in size, though near the Pulo Babi animal. In the absence of Javan material, however, it seems unsafe to attempt to distinguish the insular races.

Measurements of Sus vittatus.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without hoof.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Simalur Island	114177	Female adult	1,185	1,030	155	222	182
Do	114179	do	1,245	1,070	175	213	178
Do	114180	do	1,125	995	130	212	179
Do	114178	Male adult	1,375	1,175	200	244	206
Pulo Babi	114282	Female adult	1,320	1,120	200	245	195
Do	114283	Male adult	1,420	1,200	220	250	210
Pulo Tuangku	114415	Female adult	1,380	1,170	210	230	190
Do	114416	Male adult	1,300	1,060	240	265	225

Family SCIURIDÆ.

RATUFA FEMORALIS, new species.

Type.—Adult female (skin and skull), Cat. No. 114361, U.S.N.M. Collected on Pulo Tuangku, Banjak Islands, January 27, 1902, by Dr. W. L. Abbott. Original number, 1479.

Characters.—General appearance as in *Ratufa bunguranensis*, but color, particularly of face, feet, and under parts not as dark, and short hair of under surface of tail not forming a conspicuous, dark, median stripe. Pale flank patch more conspicuous than in any other known species.

Color.—Type: Upper parts and outer surface of limbs raw sienna, everywhere overlaid with pale ecru-drab, the combination very difficult to describe. The shorter hairs are raw sienna throughout (except slate-gray base), the longer, coarser ones light ecru-drab with indistinct dark tips. Many of the longer hairs are rather distinctly annulated. The general effect is intermediate between the clear, pale, upper surface of *Ratufa affinis* and the distinctly grizzled *R. pyrsonota*. On crown and forehead the brown nearly disappears and the ecru-drab lightens almost to cream color. On sides of body and outer surface of legs the ecru-drab gradually gives place to the raw sienna, which darkens nearly to tawny on forearm. Under parts and inner surface of legs raw sienna, paler and duller than that of back and sides and fading almost to buff in axillary region and at front of thigh. Pale flank patch well defined, whitish cream buff in strong contrast with surrounding parts. Cheeks and chin to level of ears grizzled smoke gray. Patch 10 mm. in diameter at base of whiskers, whitish gray. Ears concolor with cheeks internally, prouts brown externally. Feet prouts brown, blackening on toes, the brown extending around wrists and ankles, but much mixed with raw sienna on inner side. Tail dark prouts brown, irregularly washed with raw umber (somewhat paler than that of Ridgway), perhaps as the result of incipient bleaching. Most of the hairs of the sides of the tail are dull buff from base to about middle. This color produces a faintly suggested light median area on under surface, but not distinctly enough to form any marked contrast with edge or with the short prouts-brown appressed hairs of median line.

Skull and teeth.—The skull and teeth closely resemble those of *Ratufa bunguranensis*, but the interpterygoid space and nasal branches of the premaxillaries are narrower, and the premolar, both above and below, is larger.

Measurements.—External measurements of type: Total length, 690; head and body, 320; tail vertebræ, 370; hind foot, 72 (68). Average of eight adults from type locality: Total length, 700 (670–740); head and body, 321 (310–335); tail, 378 (360–405); hind foot, 72.6 (70–76); hind foot without claws, 67 (65–69). For details see table, page 450.

Cranial measurements of type: Greatest length, 62; basal length, 52; basilar length, 49; length of nasals, 20; least interorbital breadth, 23.4; zygomatic breadth, 37; mandible, 36.6; maxillary molar series (alveoli), 12.8; mandibular molar series (alveoli), 13.6.

Specimens examined.—Eight, all from Pulo Tuangku.

Remarks.—This squirrel is undoubtedly a near ally of the *Ratufa affinis aureiventer* of Bonhote.[a] It differs so widely, however, from Geoffroy's original description of *Sciurus aureiventer* that I have no hesitation in applying to it a new name.

RATUFA NIGRESCENS, new species.

Type.—Adult female (skin and skull), Cat. No. 114556, U.S.N.M. Collected on Pulo Mansalar off Tapanuli Bay, Sumatra, March 11, 1902, by Dr. W. L. Abbott. Original number 1641.

Characters.—One of the largest known members of the *affinis-bunguranensis* group. Color pattern as in *Ratufa bunguranensis* and *R. femoralis*, but upper parts and tail darkened almost to black. Pale flank patch obsolete.

Color.—Type: The upper parts at first sight appear to be black, but on closer inspection the color is seen to be seal brown, which in certain lights shows faint traces of raw umber. On sides of body and neck and outer surface of legs the raw umber slightly predominates and the hairs show a fine grizzle, due to minute annulations of the lighter color. Under parts and inner surface of legs raw umber, paler in axillary region and at front of thigh. Pale flank patch barely indicated by a sprinkling of cream buff hairs. Cheeks and chin to level of ears a fine grizzle of blackish and whitish; region surrounding base of whiskers slightly paler. Ears blackish externally, concoler with cheeks internally. Feet blackish. Tail uniform seal brown like back above, the basal half of the hairs tinged with dull raw umber. This color appears irregularly at the surface when hairs are disarranged, but without forming any noticeable contrast with the seal brown. The under surface of tail appears at first sight the same as the upper, but on disarranging the hairs many of them are seen to be rather thickly annulated with cream buff bands, of which there are usually about six, for the most part confined to the basal half. In certain lights these annulations produce the faint indication of a light median area, most noticeable on basal third of tail.

Skull and teeth.—The skull and teeth show no marked peculiarities. In general form the skull is longer and narrower than that of *Ratufa bunguranensis*. Teeth, as in *R. bunguranensis*, therefore relatively smaller than in *R. femoralis*.

Measurements.—External measurements of type: Total length, 750; head and body, 340; tail vertebrae, 410; hind foot, 78 (70). Average of five adult females from the type locality: Total length, 728 (705–750);

[a] Ann. and Mag. Nat. Hist., 7th ser., V, June, 1900, p. 495.

head and body, 332 (320–340); tail vertebræ, 396 (365–410); hind foot, 77.2 (75–79); hind foot without claws, 70.4 (69–72). For details see table, page 450.

Cranial measurements of type: Greatest length, 66 (64);[a] basal length, 55 (54); basilar length, 52 (50); length of nasals, 21.4 (21); least interorbital breadth, 25 (26); zygomatic breadth, 38 (40); mandible, 40.4 (40); maxillary tooth row, 13 (12.6); mandibular tooth row, 14 (13).

Specimens examined.—Five, all from the type locality.

Remarks. The five specimens of *Ratufa nigrescens* show no individual variation worthy of note. This squirrel—one of the most striking of the genus—is immediately recognizable by its rich blackish-brown upper parts and tail and yellowish-brown under parts. The tail is apparently more bushy than in the related species.

RATUFA PALLIATA Miller.

1902. *Ratufa bicolor hypoleuca* Stone and Rehn, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 134, June 4, 1902. Not *Sciurus hypoleucos* Horsfield.

1902. *Ratufa palliata* Miller, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 147, June 11, 1902; Indragiri River, Sumatra.

An immature female was taken at Tapanuli Bay, Sumatra, March 28, 1902. For measurements see table, page 450. It closely agrees with the original specimens of *Ratufa palliata* and with the skin from the Lampong district, recorded by Stone and Rehn as *R. hypoleuca*.[b]

RATUFA LÆNATA, new species.

(Plate XIX.)

Type.—Adult male (skin and skull), Cat. No. 114350, U.S.N.M. Collected on Pulo Tuangku, Banjak Islands, January 27, 1902, by Dr. W. L. Abbott. Original number, 1478.

Characters.—Externally similar to *Ratufa palliata*, but hind foot not as long (see table of measurements, p. 450); general form of skull as in *R. palliata*, but nasal branches of premaxillaries extending farther behind nasals, and anterior median termination of maxillaries narrower.

Color.—The color of *Ratufa lænata* so closely resembles that of *R. palliata* as to need no detailed description. The twelve skins show considerable variation in color, due partly to the greater or less suffusion of dark brown in the mantle, and partly to bleaching. None, however, shows any approach toward *R. bicolor* or *R. melanopepla*.

Skull and teeth.—While the general form of the skull shows no characters by which it may be distinguished from that of *Ratufa palliata*, the outline of certain individual bones is peculiar to the Tuangku animal. In *R. palliata* the premaxillaries scarcely extend behind the nasals, while in *R. lænata* their posterior extremity is

[a] Measurements in parentheses are those of a considerably older female of *Ratufa bunguranensis* (No. 104636).

[b] For the opportunity to examine this specimen I am indebted to the kindness of Mr. Witmer Stone and the officers of the Academy of Natural Sciences of Philadelphia.

usually from 2 to 4 mm. behind that of nasals (see Plate XIX). The bony palate in *R. lænata* is narrower relatively to its length than in *R. palliata*, and the anterior extension of the maxillaries which runs forward between the posterior extremities of the premaxillaries to form hinder margin of incisive foramina is very noticeably narrower (see Plate XIX). In most of the skulls the anterior extremity of the interpterygoid space is narrower than in the related species, but their character is not wholly constant.

Teeth as in *Ratufa palliata*.

Measurements.—External measurements of type: Total length, 740; head and body, 330; tail vertebræ, 410; hind foot, 76 (68). Average of eleven adults from the type locality: Total length, 732 (710–765); head and body, 334 (325–345); tail vertebræ, 398 (380–420); hind foot, 75.8 (73–79); hind foot without claws, 68.7 (65–71). For details see table, page 450.

Cranial measurements of type: Greatest length, 68.6 (68);[a] basal length, 56.8 (57); basilar length, 52 (53); length of nasals, 22 (21); least interorbital breadth, 27 (29); zygomatic breadth, 41 (42); mandible, 43.4 (42); maxillary molar series (alveoli), 13 (12.8); mandibular molar series (alveoli), 13.6 (13.8).

Specimens examined.—Twelve, all from the type locality.

Remarks.—The characters which distinguish this squirrel from its nearest ally are of an unusual kind, but their constancy is such that they must be regarded as valid. Three skulls of adult *Ratufa palliata* have been compared with the twelve of *R. lænata*.

Measurements of Ratufa.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
				mm.	*mm.*	*mm.*	*mm.*	*mm.*
Ratufa nigrescens	Pulo Mansalar	114554	Female adult	730	320	410	78	71
Do	do	114555	do	750	340	410	79	72
Do	do	114556	do	750	340	410	78	70
Do	do	114557	do	705	320	385	75	69
Do	do	114558	do	705	340	365	76	70
Ratufa femoralis	Pulo Tuangku	114358	Male adult	710	325	385	71	66
Do	do	114359	do	710	325	385	73	67
Do	do	114365	do	685	310	375	72	67
Do	do	114360	Female adult	715	325	390	75	68
Do	do	[a] 114361	do	690	320	370	72	68
Do	do	114362	do	680	320	360	70	65
Do	do	114363	do	670	310	360	72	66
Do	do	114364	do	740	335	405	76	69
Ratufa lænata	do	114346	Male adult	720	335	385	76	68
Do	do	114348	do	720	330	390	76	68
Do	do	[a] 114350	do	740	330	410	76	68
Do	do	114352	do	755	338	417	79	71
Do	do	114353	do	685	315	370	72	65
Do	do	114356	do	735	345	390	73	65
Do	do	114354	do	710	340	380	77	70
Do	do	114357	do	725	325	400	77	71
Do	do	114347	Female adult	730	330	400	76	69
Do	do	114349	do	730	330	400	75	69
Do	do	114351	do	765	345	420	76	70
Do	do	114355	do	720	330	390	74	67
Ratufa palliata	Tapanuli Bay	114517	Female young	640	270	370	80	75
Do	Indragiri River	[a] 113162	Male adult	770	345	425	84	78

[a] Type.

[a] Measurements in parentheses are those of the type of *Ratufa palliata*.

SCIURUS MANSALARIS, new species.

Type.—Adult male (skin and skull), Cat. No. 114633, U.S.N.M. Collected on Pulo Mansalar, off Tapanuli Bay, Sumatra, March 2, 1902, by Dr. W. L. Abbott. Original number, 1583.

Characters.—Size and general appearance about as in *Sciurus tenuis*, but underparts clear gray as in *S. brookei*.

Color.—Upperparts, sides of body, and outer surface of limbs a uniform fine grizzle of raw sienna and black, neither of which distinctly predominates, though the raw sienna is slightly in excess on shoulders, flanks, and outer surface of legs. Feet and sides of head like back, but paler and more closely grizzled. Underparts and inner surface of legs mouse gray washed with dull white. On chest and hind legs there is a faint brownish tinge. Hairs of tail with six color bands: (*a*) extreme base black, (*b*) 1.5 mm. raw sienna, (*c*) 2 mm. black, (*d*) 4 mm. raw sienna, (*e*) 6 mm. black, (*f*) 4 mm. whitish cream buff. The general effect above is a coarse grizzle, chiefly of black and whitish cream buff, through which the raw sienna appears when the hairs are disarranged. Below there is a broad median area of dull raw sienna edged with black, this fringed with whitish.

Skull and teeth.—The skull very closely resembles that of *Sciurus tenuis* but is a little narrower, longer, and deeper, characters that suggest, though very remotely, the much larger skull of *S. brookei*. Teeth as in *Sciurus tenuis*.

Measurements.—External measurements of type: Total length, 255; head and body, 140; tail vertebræ, 115; hind foot, 37 (35). Average of eight specimens from the type locality: Total length, 259 (245–278); head and body, 146.5 (135–158); tail vertebræ, 112 (8–122); hind foot, 37 (36–38); hind foot without claws, 35.4 (33–35). For details see table, page 452.

Cranial measurements of type: Greatest length, 38; basal length, 32; basilar length, 29; length of nasals, 12; least interorbital breadth, 13; zygomatic breadth, 22.6; diastema, 8.8; mandible, 24; maxillary tooth row (alveoli), 7.4; mandibular tooth row (alveoli), 7.

Specimens examined.—Eight, all from Pulo Mansalar.

Remarks.—This squirrel is readily distinguishable from *Sciurus tenuis* by its clear gray underparts, a character that gives it a close superficial resemblance to the much larger *S. brookei* of Borneo. Its relationships are undoubtedly with *Sciurus tenuis*, as the skull shows only a slight tendency toward the relatively narrow, elongate form characteristic of the Bornean species.

SCIURUS BANCARUS, new species.

Type.—Adult male (skin and skull), Cat. No. 114311 U.S.N.M. Collected on Pulo Bangkaru, Banjak Islands, January 17, 1902, by Dr. W. L. Abbott. Original number, 1422.

Characters.—Very similar to *Sciurus mansalaris*, but brown of upper parts more tinged with yellow and gray of underparts distinctly washed with whitish cream buff.

Measurements.—In size this animal closely agrees with *Sciurus mansalaris*, as shown by the table of measurements, page 452.

Specimens examined.—Ten, all from the type locality.

Remarks.—The characters which distinguish this squirrel from its relative of Pulo Mansalar are so strictly comparative that it is impossible to state them in such a manner as to insure positive identification of single specimens. Comparison of the eight skins of one form with the ten of the other shows, however, that the slight differences are remarkably constant, so much so that, with the exception of a single specimen from each series, there is no difficulty in assigning every skin to its proper place.

SCIURUS TENUIS Horsfield.

1824. *Sciurus tenuis* HORSFIELD, Zoological researches in Java and the neighbouring islands (pages not numbered); Singapore.

Five skins from Tapanuli Bay, Sumatra. They are in all respects typical, and show no approach to *Sciurus mansalaris* and *S. bancarus*. For measurements see table, page 452.

Measurements of Sciurus bancarus, S. mansalaris, and S. tenuis.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
				mm.	*mm.*	*mm.*	*mm.*	*mm.*
Sciurus bancarus	Pulo Bangkaru.	114308	Male, adult	262	150	112	36	32
Do	do	114309	do	266	160	106	36	32
Do	do	[a]114311	do	260	145	115	37	34
Do	do	114312	do	265	145	120	35	32.5
Do	do	114313	do	267	142	125	37	34
Do	do	114315	do	255	162	93	35	32
Do	do	114310	Female, adult	264	155	109	35	32
Do	do	114314	do	275	150	125	37	34
Do	do	114316	do	253	139	114	35	32
Do	do	114317	do	265	145	120	36	33
Sciurus mansalaris	Pulo Mansalar	114632	Male, adult	245	147	98	38	35
Do	do	[a]114633	do	255	140	115	37	35
Do	do	114634	do	270	148	122	36	33
Do	do	114636	do	260	150	110	36	33
Do	do	114637	do	255	145	110	38	35
Do	do	114635	Female, adult	245	135	110	36	33
Do	do	114638	do	278	158	120	38	35
Do	do	114639	do	263	150	113	37	34
Sciurus tenuis	Tapanuli Bay	114542	Male, adult	255	140	115	35	32
Do	do	114545	do	235	120	115	34	31.4
Do	do	114543	Female, adult	255	140	115	36	33
Do	do	114544	do	220	117	103	34	32
Do	do	114546	do	235	125	110	36	33

[a] Type.

SCIURUS ALBESCENS (Bonhote).

1901. *Sciurus notatus albescens* BONHOTE, Ann. and Mag. Nat. Hist., 7th ser., VII, May, 1901, p. 446; Acheen, Sumatra.

Six specimens from Loh Sidoh Bay, practically topotypes of the species. For measurements see table, page 456.

This squirrel shows a striking and unexpected resemblance to the *Sciurus abbottii* of the Tambelan Islands. The skins are quite indistinguishable, except that the red element of the underparts is salmon rather than rusty. The skulls show certain slight though constant differences. The rostrum is somewhat broader proportionately to its length in the Sumatran animal, and the audital bullæ are more inflated. The maxillary teeth of *Sciurus albescens*, while of the same general size as in *S. abbottii*, may be distinguished by their less thickened crowns, a character easily appreciated on comparison of the tooth rows viewed from the lingual side.

SCIURUS VITTATUS Raffles.

1822. *Sciurus vittatus* Raffles, Trans. Linn. Soc. London, XIII, p. 259; Bencoolen, Sumatra.

1901. *Sciurus vittatus* Bonhote, Ann. and Mag. Nat. Hist., 7th ser., VII, May, 1901, p. 447. (Part.)

Twelve specimens (two in alcohol, one skull without skin) from Tapanuli Bay, Sumatra. For measurements see table, page 456. The skins present no color variation worthy of note. In none is there any indication of such red in the tail as is characteristic of *Sciurus miniatus*, though a few show a tendency for the light annulations in the pencil to be more tinged with orange than they are elsewhere.

SCIURUS SATURATUS, new species.

Type.—Adult female (skin and skull), Cat. No. 114629, U.S.N.M. Collected on Pulo Mansalar, off Tapanuli Bay, Sumatra, March 9, 1902, by Dr. W. L. Abbott. Original number, 1633.

Characters.—Similar to *Sciurus vittatus* but general color darker, pale lateral stripe less well defined, though of normal extent, and tail noticeably darker than back, its pencil mostly black.

Color.—Type: Upper parts and sides a uniform fine grizzle of black and ochraceous, the latter decidedly paler and less bright than that of Ridgway. The two colors are everywhere mixed in nearly equal quantity and the hair is distinctly glossy. Outer surface of legs somewhat paler and more buffy than back; cheeks and inner surface of ear decidedly so. A distinct buff eye ring. Muzzle marked with light grayish buff. Lateral stripes of normal extent, the upper one a light grayish buff, quite different from the grayish white stripe of *S. vittatus*. Tail essentially like back, but grizzle coarse, and black element more noticeable, particularly along edge and at tip, where the pencil is almost entirely black. Under parts and inner surface of legs intermediate between the ochraceous-rufous and tawny of Ridgway, but rather darker than either. This color extends to wrist and almost to heel.

Skull and teeth.—The skull and teeth resemble those of *Sciurus vittatus*, though perhaps averaging slightly larger.

Measurements.—External measurements of type: Total length, 400; head and body, 215; tail vertebræ, 185; hind foot, 51 (47). Average of five adults from the type locality: Total length, 395 (375–411); head and body, 208 (185–221); tail vertebræ, 187 (180–190); hind foot, 51.4 (51–52); hind foot without claws, 48 (47–49). For details see table, page 456.

Cranial measurements of type: Greatest length, 52 (51);[a] basal length, 43.6 (43); basilar length, 40 (40.2); length of nasals, 16.4 (16); breadth of both nasals together anteriorly, 7.4 (8.2); diastema, 11.6 (11.8); least interorbital breadth, 18 (17.8); zygomatic breadth, 30 (30.4); mandible, 32.4 (31.4); maxillary tooth row (alveoli), 9.6 (9.6); mandibular tooth row (alveoli), 10 (9).

Specimens examined.—Five, all from Pulo Mansalar.

Remarks.—This is a well-marked form of the *Sciurus notatus* group, closely related to *S. vittatus*, but readily distinguishable by its dark general coloration, dull outer lateral stripe, and black-tipped tail. The series shows no variations worthy of special note.

SCIURUS PRETIOSUS, new species.

Type.—Adult female (skin and skull), Cat. No. 114325, U.S.N.M. Collected on Pulo Bangkaru, Banjak Islands, January 20, 1902. Original number, 1442.

Characters.—Like *Sciurus saturatus*, but average size less, red of underparts not as bright, tail not darker than back, and pencil not darker than rest of tail. Skull distinctly smaller than that of *Sciurus saturatus*.

Color.—In general the color so closely resembles that of *Sciurus saturatus* as to need no detailed description. On comparison of the two series the red of the underparts is seen to be less bright than in the Mansalar squirrel, and the pale element in the grizzle of the upperparts less yellow, though so far as possibility of description is concerned the colors are essentially the same. The most tangible difference is in the amount of black in the tail. In the Pulo Bangkaru animal this shows no tendency to form a black pencil or dark lateral fringe, as in *Sciurus saturatus*.

Skull and teeth.—Both skull and teeth are smaller than in *Sciurus saturatus* or *S. vittatus*, but I can detect no differences in form.

Measurements.—External measurements of type: Total length, 375; head and body, 200; tail vertebræ, 175; hind foot, 46 (43). Average of seven adults from the type locality: Total length, 387 (372–400); head and body, 207 (192–220); tail vertebræ, 181 (170–195); hind foot, 47.6 (46–49); hind foot without claws, 44.3 (43–46). For details see table, page 456.

[a] Measurements in parentheses are those of an adult female *Sciurus vittatus* from Tapanuli Bay, Sumatra (No. 114518).

Cranial measurements of type: Greatest length, 49.4 (52); basal length, 43 (43.6); basilar length, 40.4 (40); length of nasals, 15 (16.4); breadth of both nasals together anteriorly, 7.4 (7.4); distance from front of nasal to back of frontal, 25 (27.6); diastema, 11.6 (11.6); least interorbital breadth, 18 (18); zygomatic breadth, 29 (30); mandible, 32 (32.4); maxillary tooth row (alveoli), 9 (9.6); mandibular tooth row (alveoli), 9.8 (10).

Specimens examined.—Eight, all from the type locality.

Remarks.—The specimens of this squirrel show no noteworthy variations.

SCIURUS UBERICOLOR, new species.

Type.—Adult female (skin and skull), Cat. No. 114373, U.S.N.M. Collected on Pulo Tuangku, Banjak Islands, February 5, 1902, by Dr. W. L. Abbott. Original number, 1517.

Characters.—In general appearance like *Sciurus saturatus* and *S. pretiosus*, but red of underparts darker and duller than in either and median line of belly frequently blackish; tail not distinctly darker than back; outer lateral stripe reduced in both length and width; size nearly as in *S. saturatus*.

Color.—The general color is closely similar to that of *Sciurus saturatus* and *S. pretiosus*, but the tone of the upperparts is lighter than in the former and more red than in the latter. Tail more coarsely grizzled than back, but the general effect scarcely darker. Outer lateral stripe of the same dull color as in the related forms, but its length usually less and its width generally not more than half as great (about 5 mm. at middle in type). Underparts a duller red than in the related species, this due chiefly to the darker bases of the hairs. Along median line the dark bases increase sufficiently to form a distinct median dusky stripe in some specimens (including the type). The black lateral stripe tends to extend its inner margin in the same manner.

Skull and teeth.—The skull and teeth are essentially like those of *Sciurus saturatus*.

Measurements.—External measurements of type: Total length, 405; head and body, 215; tail vertebræ, 195; hind foot, 51 (48). Average of seven specimens from the type locality: total length, 389 (345–415); head and body, 215 (205–225); tail vertebræ, 180 (170–210); hind foot, 49.3 (46–51); hind foot without claws, 45.9 (43–48). For details see table, page 456.

Cranial measurements of type: Greatest length, 52; basal length, 44; basilar length, 41.4; length of nasals, 17; breadth of both nasals together anteriorly, 7; distance from front of nasal to back of frontal, 38; diastema, 13; least interorbital breadth, 19; zygomatic breadth, 34; mandible, 34; maxillary toothrow (alveoli), 9.6; mandibular toothrow (alveoli), 9.8.

Specimens examined.—Nine, all from the type locality.

Remarks.—While *Sciurus ubericolor* is darker beneath than in either of the two related forms, its upper parts are not as dark as in *S. saturatus* and the tail is much less suffused with black. The reduction of the pale lateral stripe easily distinguishes it from its allies.

Measurements of squirrels of the Sciurus notatus group.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
				mm.	*mm.*	*mm.*	*mm.*	*mm.*
Sciurus albescens	Loh Sidoh Bay	114154	Male adult	343	193	150	46	42
Do	do	114155	do	350	190	160	45	41.4
Do	do	114157	do	390	200	190	47	44
Do	do	114158	do	370	195	175	46	42
Do	do	114156	Female adult.	350	170	180	46	42
Do	do	114159	do	373	203	170	47	43.4
Sciurus vittatus	Tapanuli Bay	114518	do	405	220	185	48	45
Do	do	114522	do	397	200	197	50	47
Do	do	114523	do	398	206	192	47	43
Do	do	114524	do	390	190	200	48	45
Do	do	114525	do	385	205	180	48	45
Do	do	114526	do	380	215	165	48	45
Do	do	114519	Male adult	393	208	185	48	46
Do	do	114520	do	395	210	185	50	47
Do	do	114521	do	380	200	180	48	44
Sciurus saturatus	Pulo Mansalar	114627	do	411	221	190	52	48.4
Do	do	114628	do	400	220	180	51	48
Do	do	[a] 114629	Female adult.	400	215	185	51	47
Do	do	114630	do	390	200	190	52	49
Do	do	114631	do	375	185	190	51	47.4
Sciurus ubericolor	Pulo Tuangku	114366	Male adult	382	207	175	48	45
Do	do	114367	do	400	220	180	50	47
Do	do	114369	do	375	205	170	46	43
Do	do	114371	do	395	210	185	50	46
Do	do	114368	Female young	310	175	135	47	39
Do	do	114370	Female adult.	345	225	[c] 120	49	45
Do	do	114372	do	[b] 415	[b] 205	[b] 210	50	46
Do	do	[a] 114373	do	410	215	195	51	48
Do	do	114374	do	415	225	190	51	47
Sciurus pretiosus	Pulo Bangkaru	114318	Male adult	375	205	170	48	46
Do	do	114320	do	400	205	195	48	45
Do	do	114321	do	372	192	180	47	44
Do	do	114322	do	390	210	180	47	43
Do	do	114323	do	[c] 335	210	[c] 125	48	45
Do	do	114324	do	400	215	185	48	44.4
Do	do	114319	Female adult.	400	220	180	49	45
Do	do	[a] 114325	do	375	200	175	46	43

[a] Type. [b] Estimated from dry skin. [c] Tail injured.

SCIURUS EREBUS, new species.

Type.—Adult female (skin and skull). Cat. No. 114537, U.S.N.M. Collected at Tapanuli Bay, northwestern Sumatra, March 17, 1902, by Dr. W. L. Abbott. Original number, 1653.

Characters.—Similar to the Bornean *Sciurus pluto* Gray, but larger, red area on legs more extensive, and pale lateral stripe completely obliterated.

Color.—Under parts and inner surface of limbs bright chestnut (lighter and more red than that of Ridgway); elsewhere glossy black. On cheeks, feet, and outer surface of front legs the black is slightly grizzled with whitish and red, and along flanks and thighs a few hairs bear a single whitish annulation rather less than 1 mm. in length, but these markings are lost in the general black effect, except on very

close inspection. The black of cheeks extends under chin across an area about 10 mm. in width. On front legs the red area is much wider than the black, and on inner side it extends to naked surface of palm. In *S. pluto* the black area is the more extensive, and it encircles the wrist just above palm. On hind legs the same differences occur. The red area is much wider in the Sumatran than in the Bornean form, and it usually extends to edge of naked sole, though occasionally the black narrowly encircles ankle.

Skull and teeth.—The skull and teeth so closely resemble those of *Sciurus pluto* that I can detect no tangible differences.

Measurements.—External measurements of type: Total length, 485; head and body, 260; tail vertebræ, 225; hind foot, 58 (53). Average of twelve adults from the type locality: Total length, 473 (430–498); head and body, 247 (230–263); tail vertebræ, 227 (200–240); hind foot, 58.1 (57–59); hind foot without claws, 53 (51–55). For details, see table, page 457.

Cranial measurements of type: Greatest length, 58 (56);[a] basal length, 50 (49); basilar length, 46.6 (46); diastema, 13.6 (13.6); length of nasals, 17.8 (16.6); greatest breadth of both nasals together, 8.8 (8.6); least interorbital breadth, 23 (22.6); zygomatic breadth, 34.6 (34); mandible, 37 (37); maxillary toothrow (alveoli), 11 (11); mandibular toothrow (alveoli), 11 (11.4).

Specimens examined.—Twelve, all from Tapanuli Bay.

Remarks.—While *Sciurus erebus* rather closely resembles *S. pluto*, it is readily distinguishable from the Bornean animal by its greater size and by the absence of the pale lateral stripe. There is not the slightest indication of this stripe in any of the twelve skins, while in each of five specimens of *Sciurus pluto* it may be easily traced. The difference in extent of the red on the legs is a less constant character.

Measurements of Sciurus erebus.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail vertebræ.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Tapanuli Bay	114530	Male adult	480	250	230	58	53
Do	114531	do	483	250	233	57	52
Do	114533	do	430	230	200	58	54
Do	114534	do	455	240	215	57	51
Do	114539	do	470	235	235	59	53
Do	114541	do	465	245	220	58	53
Do	114532	Female adult	498	263	235	59	55
Do	114535	do	480	245	235	59	55
Do	114536	do	480	255	225	58	53
Do	[a]114537	do	485	260	225	58	52
Do	114538	do	485	245	240	59	53
Do	114540	do	470	245	225	57	52

[a] Type.

[a] Measurements in parentheses are those of an adult male *Sciurus pluto* from British North Borneo (No. 34941).

RHINOSCIURUS LATICAUDATUS (Müller and Schlegel).

1839–1844. *Sciurus laticaudatus* Müller and Schlegel, Verhandel. over de natuurlijke Geschiedenis der Nederl. overzeesche bezittingen, p. 100; Pontianak, Western Borneo.

An adult female was taken on Pulo Tuangku, Banjak Islands, February 15, 1902. Total length, 360; head and body, 230; tail vertebræ, 130; hind foot, 46 (44). Skull: Greatest length, 59; basal length, 52; basilar length, 49.4; palatal length, 31; diastema, 17; length of nasals, 21; breadth of both nasals together anteriorly, 6; least interorbital breadth, 13; zygomatic breadth, 28.6; mandible, 35.6; maxillary toothrow (alveoli), 12; mandibular toothrow (alveoli), 10.4. "Uterus contained one embryo the size of a pea. Mammæ, 4."

Family MURIDÆ.

MUS SIMALURENSIS, new species.

Type.—Adult female (skin and skull), Cat. No. 114216, U.S.N.M. Collected on Simalur Island December 14, 1901, by Dr. W. L. Abbott. Original number, 1372.

Characters.—Like *Mus pannosus* of the Butang Islands, but rather smaller; fur shorter and less coarse; color darker and less yellowish; teeth smaller; mammæ 10, as in other members of the group.

Fur.—The fur is rather close and fine in texture, much more so than that of *Mus pannosus*, though it contains many grooved bristles. These, however, are scarcely more stiff than the longer terete hairs. At middle of back the body of the fur is about 14 mm. in length, the scattered long hairs exceeding this by about 6 mm. These long hairs show no distinct tendency to increase in length on rump and lumbar region.

Color.—Back and sides a moderately coarse, but not very conspicuous grizzle of black and dull ochraceous buff, the former a little in excess on back, the latter distinctly so on sides, and tips of bristles and longer hairs with metallic iridescence. Underparts buff, rather lighter than that of Ridgway, and somewhat clouded by gray along median line of chest. Feet dull brownish. Ears and tail uniform dark brown.

Skull and teeth.—The skull is larger than that of *Mus alexandrinus*, though of essentially the same form. In size it closely approaches that of *Mus pannosus*, but the average length appears to be less than in the Butang animal. In form the skulls of *Mus simalurensis* and *M. pannosus* closely resemble each other, except that the rostrum is more slender in the Simalur rat and the incisive foramina are longer, narrower, and more nearly parallel-sided. Teeth as in *Mus pannosus*, but smaller.

Measurements.—External measurements of type: Total length, 402;

head and body, 204; tail vertebræ, 198; hind foot, 42.4 (40). Average of 5 adults from the type locality: Total length, 388 (377–402); head and body, 206 (200–213); tail vertebræ, 182 (176–198); hind foot, 40.4 (39.2–42.2); hind foot without claws, 37.8 (36–40). For details, see table, page 459.

Cranial measurements of type: Greatest length, 47.4 (46);[a] basal length, 41.8 (40); basilar length, 39 (37); diastema, 13 (12.4); length of incisive foramen, 9 (8); combined breadth of incisive foramina, 3.4 (3.8); length of nasals, 18 (17.6); greatest breadth of both nasals together, 5.2 (5.6); zygomatic breadth, 23 (22); least interorbital breadth, 7.4 (7); breadth of brain case above roots of zygomata, 17 (17); depth of brain case at front of basioccipital, 12 (11.4); frontopalatal depth at posterior extremity of nasals, 11.8 (11.6); mandible, 28 (28); maxillary tooth row (alveoli), 8 (8.4), mandibular tooth row (alveoli), 8 (8.4).

Specimens examined.—Thirty-two from the following localities: Simalur Island (main island), 8 (2 in alcohol); Simalur Island (Pulo Siumat), 6 (1 skull without skin); Pulo Lasia, 16 (3 in alcohol; 3 skulls without skins); Pulo Babi, 2 (skulls only).

Remarks.—This is a well-defined member of the *Mus rattus* group, most closely related, apparently, to the form occurring on the Butang Islands on the opposite side of Sumatra. Its presence on Simalur and the neighboring islands may have been originally due to human agency, though there is no reason to suppose that the animal has been introduced within historic times.

Measurements of Mus simalurensis.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Simalur Island	114214	Male adult	389	213	176	39	36
Do	114215	do	393	211	182	40	36
Do	114213	Female young	357	190	167	38	35
Do	[a] 114216	Female adult	402	204	198	42.2	40
Do	114217	do	380	201	179	40	38
Do	114218	do	377	200	177	41	39
Pulo Siumat	114221	Male adult	415	224	191	42	38.6
Do	114225	do	413	212	201	42.4	40
Do	114222	Female adult	383	204	179	40	38
Do	114223	Female young	342	172	170	39.6	37
Do	114224	Female adult	375	198	177	41.4	38.4
Pulo Lasia	114257	Male adult	433	225	208	43	39.4
Do	114260	do	417	205	212	41	39
Do	114261	do	411	210	201	42.4	40
Do	114262	Male young	385	178	207	42	40
Do	114253	Female young	356	176	180	40	38
Do	114254	Female adult	456	231	225	42.2	40
Do	114255	do	437	225	212	40.4	39
Do	114256	Female young	370	182	188	40.4	39
Do	114258	Female adult	445	227	218	43.4	41.2

[a] Type.

[a] Measurements in parentheses are those of an adult female *Mus pannosus* (No. 104115) from Pulo Adang, Butang Islands.

MUS SURDUS, new species.

Type.—Adult male (skin and skull). Cat. No. 114184, U.S.N.M. Collected on Simalur Island December 11, 1901, by Dr. W. L. Abbott. Original number, 1359.

Characters.—Similar to *Mus concolor* Blyth and *Mus pullus* Miller, but larger and paler.

Fur and external characters in general.—The fur, tail, ears, feet, etc., are as in *Mus concolor* and *Mus pullus*. Mammae, i. 2–2, p. 2–2=8.

Color.—Back and sides a coarse, inconspicuous grizzle of dull ochraceous buff and blackish brown, the former slightly in excess on back and distinctly predominating on sides. Underparts and inner surface of limbs dirty white, tinged with cream buff. In the type there is a fairly well defined line of demarcation between the color of sides and that of belly. This contrast, though not always so conspicuous, is invariably more noticeable than in the type of *Mus pullus* or the two specimens of *Mus concolor* that I have examined. Ears blackish brown externally, lightly sprinkled with fine, silvery hairs internally. Feet dirty whitish.

Skull and teeth.—Both skull and teeth are noticeably larger than in *Mus concolor* and *Mus pullus*, but I can detect no tangible difference in form.

Measurements.—External measurements of type: Total length, 265; head and body, 127; tail vertebræ, 138; hind foot, 28 (26). Average of 21 adults from the type locality: Total length, 268 (238–324); head and body, 130 (112–143); tail vertebræ, 139 (119–182); hind foot, 27 (26–28.2); hind foot without claws, 25.4 (24–27). For details see table, page 461.

Cranial measurements of type: Greatest length, 33 (30);[a] basal length, 28.6 (26); basilar length, 26 (23); diastema, 8.8 (8); length of incisive foramen, 6.4 (5.4); combined breadth of incisive foramina, 2.8 (2); length of nasals, 12 (11); greatest combined breadth of nasals, 3.4 (3); zygomatic breadth, 15.4 (13.6); least interorbital breadth, 5 (4); breadth of brain case above roots of zygomata, 13.6 (13); depth of brain case at front of basioccipital, 9.6 (9); frontopalatal depth at posterior extremity of nasals, 7.4 (6.6); mandible, 18.8 (15.4); maxillary tooth row (alveoli), 5.6 (4.6); mandibular tooth row (alveoli), 5.6 (4.6).

Specimens examined.—Thirty-two (11 in alcohol), all from the type locality.

Remarks.—Though closely related to *Mus concolor* and *Mus pullus* this species appears to be well differentiated. Like *Mus simalurensis* it probably owes its introduction and therefore its existence to prehistoric man.

[a] Measurements in parantheses are those of the type of *Mus pullus.*

Measurements of Mus surdus.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
malur Island	114181	Male adult	270	130	140	27	25
Do	114182	....do	270	130	140	27	25
Do	114183	....do	264	130	134	26	24
Do	[a] 114184	....do	265	127	138	27.8	26.4
Do	114185	....do	276	132	144	27	26
Do	114186	....do	249	125	124	26.2	25
Do	114187	....do	270	130	140	26.4	25
Do	114190	....do	266	135	131	27	26
Do	114191	....do	272	129	143	26	25
Do	114192	....do	324	142	182	28	27
Do	114193	....do	285	143	142	28	26
Do	114194	....do	298	143	155	28	26.4
Do	114196	....do	285	134	151	28.2	26
Do	114198	....do	269	129	140	26	24.4
Do	114200	....do	273	133	140	27.2	26
Do	114201	....do	260	135	125	28	27
Do	114188	Female adult	240	121	119	26	25
Do	114189	....do	243	116	137	27	25
Do	114195	....do	238	112	126	26	25
Do	114197	....do	268	124	141	28	26
Do	114199	....do	251	125	126	26.2	25

[a] Type.

MUS FIRMUS Miller.

1902. *Mus firmus* Miller, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 155; June 11, 1902; Linga Island, off east coast of Sumatra.

An immature rat taken at Tapanuli Bay, 8 specimens (1 in alcohol) rom Pulo Tuangku, and 7 (1 skull without skin) from Pulo Bangaru I can not distinguish satisfactorily from the *Mus firmus* of Linga sland. The skins from Pulo Bangkaru and that from Tapanuli Bay re practically indistinguishable from the original series. Those from 'ulo Tuangku are, however, not as clear buff beneath, as the hairs of he lateral portions of the belly have distinct gray bases, and this color ppears slightly at surface. The series is too small to prove that this ifference is constant. For measurements see table, page 462.

MUS DOMITOR, new species.

Type.—Adult female (skin and skull), Cat. No. 114621, U.S.N.M. 'ollected on Pulo Mansalar at entrance to Tapanuli Bay, Sumatra. Iarch 4, 1902, by Dr. W. L. Abbott. Original number, 1592.

Characters.—Similar to *Mus firmus* but under parts so little tinged vith yellow as to form no marked contrast with color of sides. Mamnæ 8, as in *Mus firmus* and related species.

Fur and general external features.—The external characters, other han color, are so like those of *Mus firmus*, *Mus integer*, and the reviously known members of the group as to need no description.

Color.—Upper parts a fine grizzle of blackish brown and pale, dull, uff, the two colors nearly equally mixed on the back, but the buff in xcess on the sides, where, however, it is clouded by the appearance

at surface of the gray (very nearly Ridgeway's No. 6) of the under fur. The longer hairs show a distinct bluish luster. Under parts and inner surface of legs gray (about Ridgeway's No. 6) faintly washed with grayish buff, the contrast between the color of this region and that of sides very slight. Head similar to back, but grizzle more fine. Feet dull, dark brown. Ears and tail uniform blackish.

Skull and teeth. The skull and teeth so closely resemble those of *Mus firmus* that I can find no tangible characters by which to distinguish them.

Measurements.—External measurements of type: Total length, 490; head and body, 243; tail vertebræ, 247; hind foot, 47 (44). Average of 5 specimens from the type locality: Total length, 457 (400–497); head and body, 227 (200–251); tail vertebræ, 230 (200–252); hind foot, 46.4 (45–48); hind foot without claws, 43.6 (42–45). For details see table, page 462.

Cranial measurements of type: Greatest length, 53 (53);[a] basal length, 46.4 (46); basilar length, 43.6 (43); length of nasals, 21 (21.4); greatest combined breadth of nasals, 5.8 (5.6); diastema, 15 (15); zygomatic breadth, 26 (27); least interorbital breadth, 8 (8); depth of brain case at front of basioccipital, 13 (13); frontopalatal depth at posterior extremity of nasals, 12.4 (13); mandible, 31.4 (32.4); maxillary tooth row (alveoli), 9 (9.4); mandibular tooth row (alveoli), 9.6 (10).

Specimens examined.—Seven (one skull without skin), all from Pulo Mansalar.

Remarks.—The distinctness of this species from the *Mus firmus* of the near-by mainland is unquestionable.

Measurements of Mus firmus and Mus domitor.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws
				mm.	*mm.*	*mm.*	*mm.*	*mm.*
Mus firmus	Pulo Bangkaru	114285	Female adult	435	232	203	45	
Do	do	114286	do	441	233	208	46	
Do	do	114287	do	408	216	192	43.4	
Do	do	114288	do	440	230	210	45	
Do	do	114289	do	411	218	193	44	
Do	do	114290	Male adult	412	212	200	46	
Do	Pulo Tuangku	114378	Female adult	457	220	237	50	
Do	do	114380	do	435	222	213	46.4	
Do	do	114382	do	482	242	240	48	
Do	do	114384	do	485	245	240	47	
Do	do	114379	Male adult	458	228	230	49	
Do	do	114381	do	487	249	238	48	
Do	do	114383	do	530	270	260	50	
Mus domitor	Pulo Mansalar	114620	Female adult	400	200	200	46	
Do	do	[a]114621	do	490	243	247	47	
Do	do	114622	Female young	384	185	199	42	
Do	do	114623	Male adult	485	233	252	48	
Do	do	114624	do	413	207	206	45	
Do	do	114625	do	497	251	246	46	

[a] Type.

[a] Measurements in parentheses are those of the type of *Mus firmus.*

MUS FREMENS Miller.

1902. *Mus fremens* MILLER, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 154, March, 1902; Sinkep Island, off east coast of Sumatra.

Twenty-four specimens, from the following localities: Pulo Tuangku, 7 (2 skulls without skins); Pulo Bangkaru, 1; Pulo Mansalar, 7 (1 skull without skin); Tapanuli Bay, 9 (5 skulls without skins). This series shows variation in both size and color, but for the present I prefer to refer it as a whole to *Mus fremens*. None of the skins show any close approach to the bright colors of *Mus vociferans*. For measurements, see table.

Measurements of Mus fremens.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Pulo Bangkaru	114307	Female young	481	207	274	45	43
Pulo Tuangku	114401	Male adult	567	245	322	47	45
Do	114402	do	585	257	328	48	45
Do	114403	Male young	515	228	287	45	43
Do	114404	Male adult	578	250	328	48	45.4
Do	114405	do	572	249	323	50	48
Tapanuli Bay	114451	Female adult	610	242	368	46	44.4
Do	114452	do	579	225	354	46	44
Do	114453	Male adult	611	236	375	48	45
Do	114454	do	605	240	365	47	45.4
Pulo Mansalar	114581	Female adult	480	241	*a*239	46	44
Do	114586	do	483	220	263	44.4	42
Do	114582	Male young	495	210	285	44	41.4
Do	114583	Male adult	549	250	299	48	45
Do	114584	do	522	218	304	45	43
Do	114585	do	520	230	290	45	43

a Tail damaged.

MUS ASPER Miller.

1900. *Mus asper* MILLER, Proc. Biol. Soc. Washington, XIII, April 21, 1900, p. 145; Trong, Lower Siam.

An adult male (skin and skull) and female (skull only) from Pulo Tuangku, Banjak Islands, and an adult female (in alcohol) from Tapanuli Bay. These specimens so closely resemble *Mus asper* that without further material I am unable to distinguish them. The male from Pulo Tuangku measures: Total length, 249; head and body, 140; tail, 109; hind foot, 29.6 (28). The female from Tapanuli Bay measures: Total length, 210; head and body, 105; tail, 105; hind foot, 27 (26).

MUS LINGENSIS Miller.

1900. *Mus lingensis* MILLER, Proc. Washington Acad. Sci., II, August 20, 1900, p. 206; Linga Island, off east coast of Sumatra.

Forty specimens, as follows: Pulo Bangkaru, 15 (1 in alcohol, 4 skulls without skins); Pulo Tuanku, 12 (2 in alcohol, 3 skulls without skins); Tapanuli Bay, Sumatra, 13 (1 in alcohol, 7 skulls without skins). For measurements, see table, page 464.

Many of the skins are in fresh, unworn pelage, a stage in which they differ almost as strongly from the bright-colored *Mus surifer* of the Malay Peninsula as was the case with the original specimens taken in midsummer. In fact, the general color of the rats of this group appears to be only slightly affected by abrasion of the fur. In the six specimens from Tapanuli Bay there is no indication of a dark collar. The collar is present in about half the skins from the Banjak Islands, though in none is it developed as in the Pulo Mansalar form.

Measurements of Mus lingensis.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Pulo Bangkaru	114292	Male adult	341	191	153	41	39
Do	114294	.....do	372	205	167	42	39.4
Do	114295	.....do	328	180	148	39	36
Do	114296	.....do	....	....	....	40	38
Do	114299	.....do	358	200	158	39.4	37.4
Do	114300	.....do	*b* 332	204	*b* 128	40	38
Do	114301	.....do	332	180	152	39	37
Do	114293	Female adult	343	184	159	38.4	36
Do	114297	.....do	*b* 330	200	*b* 130	36.4	35.4
Do	114298	.....do	380	205	175	41.6	40
Pulo Tuangku	114387	Male young	316	182	134	38.4	36
Do	114389	Male adult	330	183	147	39.2	36
Do	114392	.....do	342	191	151	40.6	37
Do	114388	Female adult	361	204	157	39	37
Do	114390	.....do	331	177	154	41	37.4
Do	114391	.....do	340	192	148	39	36
Do	114393	.....do	334	186	148	39	37
Loh Sidoh Bay	114161	Male young	295	145	150	37	35
Tapanuli Bay	114438	.....do	330	173	157	39	37
Do	114436	Female adult	320	167	153	38	36.2
Do	114437	.....do	394	213	181	39	36.4
Do	114439	Female young	315	162	153	39	37
Do	114440	Female adult	414	218	196	41.6	40
Linga Island	101610	Male adult	362	203	159	38	37
Do	101612	.....do	400	216	184	43	42
Do	*a* 101614	.....do	387	216	171	42	40.4
Do	113044	.....do	354	188	166	41	39
Do	113048	.....do	389	219	170	43	41
Do	113049	.....do	420	237	183	41	39.4
Do	113050	.....do	383	201	182	39	36.4
Do	101611	Female adult	375	210	165	38	36
Do	113040	.....do	380	205	175	40	38
Do	113042	.....do	*a* 310	220	*a* 90	39.4	37
Do	113047	.....do	330	177	153	41	38

a Type. *b* Tail imperfect.

MUS CATELLIFER, new species.

Type.—Adult female (skin and skull). Cat. No. 114590, U.S.N.M. Collected on Pulo Mansalar, off Tapanuli Bay, Sumatra, March 3, 1902, by Dr. W. L. Abbott. Original number, 1587.

Characters.—In general similar to *Mus lingensis*, but darker; lower leg entirely tawny, and throat with broad cross-band of same color.

Fur and general external features.—The external characters, color excepted, agree so closely with those of *Mus lingensis* as to need no special description. The spines on the back are rather less coarse than in the related species.

Color.—Type: Back and sides tawny ochraceous, considerably paler than that of Ridgway, everywhere heavily clouded by the blackish brown of the spines and longer hairs. On middle of back the dark color is greatly in excess, but on sides the tawny-ochraceous slightly predominates. Crown and forehead like back; cheeks clear, dull, tawny-ochraceous. Outer surface of limbs tawny-ochraceous, paler than that of sides, and somewhat dulled by appearance at surface of slaty bases of hairs. The tawny-ochraceous completely encircles heel and wrist, extending up to middle of lower leg and forearm. Underparts dull white, distinctly marked with cream buff. Throat just in front of forelegs crossed by an ochraceous buff band about 25 mm. in width. Feet dull whitish. Ears and tail blackish brown, the latter indistinctly whitish beneath and at tip.

Nine of the skins show no variation worthy of note, but the other three (Nos. 114611, 114612, and 114613) are so peculiar as to suggest their specific distinctness. In these the tawny-ochraceous is absent from median dorsal region, the whole of which is consequently a clear slaty brown from shoulders to base of tail, strongly contrasted with color of sides. Entire ventral surface dull, light, ochraceous-buff, slightly marked with whitish along median line. Otherwise as in the type. As these specimens show no peculiarities other than color, I think they are to be regarded as a dichromatic phase of *Mus catellifer*.

Skull and teeth.—The skull and teeth are not distinguishable from those of *Mus lingensis*.

Measurements.—External measurements of type: Total length, 348; head and body, 202; tail vertebræ, 146; hind foot, 40 (39). Average of nine specimens from type locality: Total length, 350 (309–398); head and body, 195 (176–221); tail vertebræ, 155 (133–177); hind foot, 41 (40–43); hind foot without claws, 38.9 (37.4–41). For details see table, page 466.

Cranial measurements of type: Greatest length, 46 (47.5);[a] basal length, 39 (40.4); basilar length, 37 (37.5), diastema, 13 (13.4); length of incisive foramen, 7 (7); combined breadth of incisive foramina, 4.4 (4); length of nasals, 17 (19); greatest combined breadth of nasals, 5 (5.4); zygomatic breadth, 20 (20); least interorbital breadth 6.6 (6.8); mandible, 25 (25.4); maxillary tooth row (alveoli), 7 (8); mandibular tooth row (alveoli), 7 (7.2).

Specimens examined.—Thirty-two (2 in alcohol; 18 skulls without skins), all from Pulo Mansalar.

[a] Measurements in parentheses are those of the type of *Mus lingensis*.

Measurements of Mus catellifer.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Pulo Mansalar	114588	Female adult	[b]322	220	[a]102	41	39
Do	114589	do	376	208	168	40	37.4
Do	[a]114590	do	348	202	146	40	38
Do	114593	do	366	222	144	38	36
Do	114596	do	333	177	156	40	38
Do	114612	do	383	219	164	41	39
Do	114591	Male adult	338	183	155	43	41
Do	114592	Male young	297	157	140	40	37
Do	114594	Male adult	398	221	177	41	38
Do	114595	Male young	333	186	147	42	39.4
Do	114611	do	328	179	149	42	40
Do	114613	do	309	176	133	40	39

[a] Type. [b] Tail damaged.

LENOTHRIX, new genus.

Type: *Lenothrix canus*, new species.

Characters.—Form as in the larger species of *Mus;* tail longer than head and body. Fur densely woolly, interspersed with long, straight hairs. Feet as in *Mus*, but plantar tubercles unusually large. General form of skull as in *Mus*, but supraorbital ridges greatly developed, somewhat as in *Tylomys*. Teeth essentially as in *Lenomys*,[a] but width of upper molars only about half that of palate, and supplemental reentrant angles on inner side of these teeth less strongly developed.

LENOTHRIX CANUS, new species.

(Plate XVIII.)

Type.—Adult male (skin and skull). Cat. No. 114386, U.S.N.M. Collected on Pulo Tuangku, January 27, 1902, by Dr. W. L. Abbott.

Characters.—A slender, bluish gray rat. In external appearance similar to *Lenomys meyeri* as figured by Meyer,[b] but considerably smaller (head and body 236 instead of 290; hind foot 42 instead of 46), and with tail longer than head and body.

Fur.—The fur is composed of three elements: (1), a fine, dense, woolly underfur, the hairs of which at middle of back are about 12 mm. in length; (2), slender, straight, terete hairs, the length of which in same region averages about 25 mm., and (3), weak, flattened hairs intermediate in length between the two other kinds and most abundant on sides and underparts. The flattened hairs are very inconspicuous and might readily pass unnoticed. It is the abundant woolly underfur that determines the character of the pelage and gives the animal a very different appearance from *Mus ferreocanus*, which it

[a] As figured by Thomas, Trans. Zool. Soc. London, XIV, pl. XXXVI, fig. 1.

[b] Abhandl. u. Berichte des k. Zool. u. Anthrop.-Ethn. Museums zu Dresden, VII, 1899, pl. VIII.

rather closely resembles in color. In the type specimen there is an almost naked area about 4 mm. wide and 70 mm. in length extending along median line of belly to posterior portion of chest. It has the appearance of a normal character.

Color.—Upper parts and outer surface of limbs ecru-drab, irregularly tinged with broccoli-brown and clouded, particularly along middle of back, by the blackish long hairs. Both under fur and long hairs have a distinctly glossy texture, which causes much variation in the exact shade as the skin is viewed in different lights. Cheeks light broccoli-brown. Whiskers shining black. Underparts and inner surface of limbs cream-buff, the line of demarcation between this color and that of sides fairly well defined. Feet dirty whitish, shaded with ecru-drab, this color extending around heel. Ears blackish. Tail blackish throughout basal fourth, the rest white.

Tail.—The tail shows no peculiarities of importance. It is distinctly and uniformly annulated, about 11 rings to the centimeter at middle. The rings are not very clearly divided into scales except toward base. Beyond middle the rings become much more closely crowded, but they retain their distinctness to extreme tip. On basal fourth the hairs which spring from between the rings are too minute to cause any concealment of the annulation, but beyond this region they increase in length and slightly obscure the outlines of the rings. At tip they are about 5 mm. long.

Ears.—The ears are of moderate size and normal form. Laid forward they extend about to eye. The surface of the ear is naked, except for a sprinkling of minute blackish hairs.

Skull.—The skull is in size and general form not unlike that of a large house rat. The brain case, however, is less deep, the audital bullæ are much smaller, the incisive foramina are shorter, the nasals flare abruptly anteriorly, and the plate of the maxillary which forms outer wall of antorbital foramen is not produced forward beyond level of upper zygomatic root. The most striking differences are found in the interorbital region. In general contour this region is much as in *Mus norvegicus*, but the supraorbital beads are developed into upturned blade-like ledges between which the main surface of the frontal lies at the bottom of a distinct trough. A similar condition is suggested by some skulls of very aged members of the *Mus surifer* group and by those of species of *Tylomys*.

Teeth.—Incisors as in *Mus norvegicus*, except that those of the upper jaw are a little less strongly curved. Molars (Plate XVIII, figs. 4 and 5) slightly larger than those of the house rat. *First upper molar:* The anterior ridge contains three distinct cusps, the outermost of which is nearly as large as the innermost and situated distinctly farther forward. As a result, the outer side of the tooth appears longer than the inner—the exact opposite to the condition in *Mus*. Between central and inner

cusps there is a distinct reentrant angle. Another small reentrant angle lies at the posterior base of the outer cusp. The second ridge is practically a repetition of the first, except that the reentrant angle between middle and inner cusps is broader and not as deep, while that at posterior base of outer cusp is better developed. There is also a rudimentary reentrant angle at front of outer cusp, so that the resulting form of the cusp is an imperfect trefoil with a large median lobe, a posterior one of nearly the same size, and a minute anterior segment. In the type the process of attrition has extended far enough to unite the median ridge with the posterior along the inner edge. Third ridge with median cusp larger than in either first or second, the outer cusp rather smaller than that of first or second, and inner cusp obsolete. There is a distinct reentrant angle at posterior base of outer cusp. *Second upper molar:* Anterior ridge represented by a large inner cusp and a minute outer one, both joined in present state of wear to front of main cusp of second ridge. Second like that of first tooth, but with outer cusp smaller and lacking the anterior limb of the trefoil. Third ridge as in anterior tooth. *Third upper molar:* Anterior ridge represented by a large internal cusp, as well developed as that of middle tooth, but quite distinct from second ridge. Second ridge formed by a simple, transverse loop, narrow on the inner side, but expanding externally to a rudimentary median cusp. Third ridge consisting of a single large cusp, probably the median. It is fully as large as the median cusp of the other teeth. *First lower molar:* This tooth consists of three very similar bilobate cross ridges, slightly convex or concave in front, deeply concave behind. The anterior is somewhat concave anteriorly and is preceded by a small median tubercle. A similar but rather smaller tubercle lies between first and second loop on outer side, and a still smaller one between the same loops on inner side. Posterior loop like second, except that there is a small reentrant angle on outer side. It is followed by a median tubercle, rather larger than that at front of tooth. *Second lower molar:* Essentially a duplication of the second and third loops and posterior tubercle of first tooth, but anterior lobe with a rudimentary external tubercle and reentrant angle on outer side of second lobe deeper. *Third lower molar:* This tooth is reduced to an anterior loop about like that of middle tooth, and a broad, crescentic posterior loop, the slightly concave side of which is directed forward.

Measurements.—External measurements of type: Total length, 534; head and body, 236; tail, 298; hind foot, 41 (38.6).

Cranial measurements of type: Greatest length, 49.6; basal length, 44.6; basilar length, 42.6; palatal length, 22; least width of palate between anterior molars, 4.8; diastema, 14.6; length of incisive foramen, 6.8; combined breadth of incisive foramina, 3.2; length of nasals, 18; greatest combined breadth of nasals, 6.6; zygomatic breadth, 25

least interorbital breadth, 5.8; breadth of brain case above roots of zygomata, 17; depth of brain case at front of basioccipital, 11.6; fronto-palatal depth at posterior extremity of nasals, 11.4; least depth of rostrum immediately behind incisors, 9.6; mandible, 28.6; maxillary tooth row (alveoli), 9; width of front upper molar, 2.6; mandibular tooth row (alveoli), 8; width of front lower molar, 2.

Specimens examined.—One, the type.

Remarks.—*Lenothrix ravus* is easily recognizable among Malayan rats by its woolly fur, long tail, and bluish gray color, combined with the rather large size. In general appearance it somewhat resembles *Mus ferreocanus*, but the quality of the fur in the two animals is quite unlike.

FAMILY HYSTRICIDÆ.

TRICHYS MACROTIS, new species.

Type.—Adult female (skin and skull). Cat. No. 114488, U.S.N.M. Collected at Tapanuli Bay, northwestern Sumatra, February 20, 1902, by Dr. W. L. Abbott. Original number, 1555.

Characters.—Similar to the Bornean *Trichys fasciculata* (Shaw) but with longer ears; skull with broader, more strongly angled hamulars.

Ears.—The ears differ from those of *Trichys fasciculata* in form as well as in size. The anterior border is very moderately convex and the tip is more broadly rounded off than in the Bornean animal. These two characters, in connection with the greater length, give the ear an almost spatulate appearance quite different from the contour of the ear of the related species.

Color.—The color so exactly resembles that of *Trichys fasciculata* as to need no description.

Skull and teeth.—The skull closely resembles that of *Trichys fasciculata*, except that the hamular processes of the pterygoids are of a distinctly different form. In *T. fasciculata* these processes are slender and uniformly curved throughout, the lower margin slightly thickened and the tip tapering rather abruptly to a point. In *T. macrotis* they are much wider, there is an abrupt angle near middle, the lower edge is not thickened, and the tip is broadened and swollen into a distinct head.

Teeth as in *T. fasciculata.*

Measurements.—External measurements of type: Total length, 653; head and body, 428; tail vertebræ, 225; hind foot, 64 (61); ear from meatus, 28. Average of four adults from the type locality: Total length, 614 (590–653); head and body, 420 (410–428); tail vertebræ, 197 (180–225); hind foot, 64 (62–66); hind foot without claws, 60.3 (58–62). For details, see table, page 470.

Cranial measurements of type: Greatest length, 82 (84[a]); basal

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[a] Measurements in parentheses are those of a young adult male *Trichys fasciculata* from Mount Salikan, Borneo (No. 83940).

length, 72 (72); basilar length, 68 (67); length of nasals, 27 (25.4); diastema 24 (24); zygomatic breadth, 44 (44.4); least interorbital breadth, 16 (19); mandible, 52.4 (52); maxillary toothrow (alveoli), 13.4 (14.8); mandibular toothrow (alveoli), 14.8 (15).

Specimens examined.—Five, all from the type locality.

Remarks.—Though closely related to the Bornean form, *Trichys macrotis* appears to be readily distinguishable by its large ears and peculiar hamulars.

An embryo with head and body about 40 mm. in length clearly shows that scaly integument, the vestiges of which in the adult have been called attention to by Jentink.[a] The scales are very distinct on the back, sides, thigh, upper arm, and proximal third of tail, much more so, in fact, than in an embryo *Manis javanica* of about the same size. The largest average a little more than 1 mm. in length. Longitudinally there are about 52 rows, each of which contains 24 scales at middle of body. At the posterior border of each scale the incipient spines appear as minute rounded projections, of which the central is usually the best developed. Five of these rudiments to each scale appears to be the usual number, though seven may occasionally be counted. The middle and terminal portions of the tail lack scales, but in a favorable light traces of rings are visible along the second third. Near tip the tail rather abruptly thickens, and its surface becomes somewhat rugose.

Measurements of Trichys macrotis.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail vertebræ.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Tapanuli Bay	114487	Female adult	....	425	....	64	61
Do	[a] 114488	do	653	428	225	64	60
Do	114491	do	617	422	195	60	57
Do	114489	Male adult	590	410	180	66	62
Do	114490	do	600	415	185	62	58

[a] Type.

Family VIVERRIDÆ.

HERPESTES BRACHYURUS Gray.

1837. *Herpestes brachyurus* Gray, Mag. Nat. Hist., I, November, 1837, p. 578; "Indian Islands."

A pair of adults, Tapanuli Bay, Sumatra, March 24 and 26, 1902. Measurements: Total length, male, 630, female, 650; head and body, male, 430, female, 435; tail vertebræ, male, 200, female, 215; hind foot, male, 83, female, 82; hind foot without claws, male, 78, female, 78.

[a] Notes from the Leyden Museum, XVI, 1894, p. 209.

HEMIGALE HARDWICKII Gray.

1830. "*Viverra hardwickii* GRAY, Spic. Zool., II, p. 9."

Adult female, Tapanuli Bay, Sumatra, February 12, 1902. Measurements: Total length, 830; head and body, 520; tail vertebræ, 310; hind foot, 73 (71).

PARADOXURUS HERMAPHRODITUS (Pallas).

1778. *Viverra hermaphrodita* PALLAS, in Schreber, Säugthiere, III, p. 426; "Barbary."

Six specimens from Simalur Island. For measurements, see table, page 471.

Dr. Abbott writes that the musang of Simalur Island is lighter in weight and much more slender in form than that of the Malay Peninsula. The measurements, however, show no appreciable differences, and I can detect none in the skins or skulls.

Measurements of Paradoxurus hemaphroditus.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail vertebræ.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Simalur Island	114171	Male adult	845	465	380	68	65
Do	114174	Young male	758	388	370	66	63
Do	114175	Male adult	875	485	390	71	70
Do	114172	Female adult	883	483	400	66	65
Do	114173	do	865	470	395	71	69
Do	114176	do	885	475	410	70	69

Family MUSTELIDÆ.

AONYX CINEREA (Illiger).

1815. *Lutra cinerea* ILLIGER, "Abhandl, Akad. Berlin, 1811, p. 99." Java.

An adult female was taken at Tapanuli Bay, Sumatra, on March 27, 1902. Measurements: Total length, 760; head and body, 470; tail vertebræ, 290; hind foot, 82.

Family GALEOPITHECIDÆ.

GALEOPITHECUS VOLANS (Linnæus).

1758 [*Lemur*] *volans* LINNÆUS, Syst. Nat., I, 10th ed., p. 30; Asia.

Two specimens from Pulo Tuangku, Banjak Islands.

Measurements of Galeopithecus volans.

Locality.	Number.	Sex.	Total length.	Head and body.	Tail vertebræ.	Hind foot.	Hind foot without claws.
			mm.	*mm.*	*mm.*	*mm.*	*mm.*
Pulo Tuangku	114375	Female, adult	620	385	235	61	55
Do	114376	Male, adult	550	335	215	60	53.6

Family ERINACEIDÆ.

GYMNURA GYMNURA (Raffles).

1822. [*Vinerra*] *gymnura* Raffles, Trans. Linn. Soc., London, XIII, p. 272; Bencoolen, Sumatra.

One adult male, Tapanuli Bay, Sumatra, March 29, 1902. For measurements see table, page 472.

Family TUPAIIDÆ.

TUPAIA FERRUGINEA (Raffles).

1822. *Tupaia ferruginea* Raffles, Trans. Linn. Soc. London, XIII, p. 256; Singapore.

Five specimens, two from Loh Sidoh Bay and three (one skull without skin) from Tapanuli Bay. For measurements see table, page 472. Both skins and skulls closely agree with those from the southern extremity of the Malay Peninsula and show no approach toward the *Tupaia phæura*[a] of Sinkep Island.

TUPAIA TANA Raffles.

1822. *Tupaia tana* Raffles, Trans. Linn. Soc. London, XXIII, p. 257; Bencoolen, Sumatra.

A pair of adults, Pulo Tuangku, Banjak Islands, January 29 and 31, 1902. For measurements see table, page 472.

TUPAIA MALACCANA Anderson.

1879. *Tupaia malaccana* Anderson, Anat. and Zool. Researches, p. 134; Malacca.

A male was taken at Tapanuli Bay, Sumatra, March 22, 1902. For measurements see table, page 472.

Measurements of Gymnura and Tupaia.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.	Hind foot without claws.
				mm.	*mm.*	*mm.*	*mm.*	*mm.*
Gymnura gymnura	Tapanuli Bay	114551	Male, adult	632	377	255	53	50
Tupaia ferruginea	Loh Sidoh Bay	114152	Female, adult	365	190	175	45	43
Do	do	114153	Male, adult	a 330	190	a 140	47	44
Do	Tapanuli Bay	114548	Female, adult	365	195	170	45	42.
Do	do	114549	Male, adult	390	200	190	47	45
Tupaia tana	Pulo Tuangku	114412	do	375	215	160	46	43
Do	do	114413	Female, adult	365	205	160	45	42
Tupaia malaccana	Tapanuli Bay	114550	Male, adult	284	132	152	43	41

[a] Tail imperfect.

[a] Miller, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 157, June 11, 1902.

Family VESPERTILIONIDÆ.

MYOTIS MURICOLA (Gray).

1846. *Vespertilio muricola* Gray "Catal. Mamm., etc., Nepal and Thibet, p. 4, (ex Hodgson, *nomen nudum*);" Nepal.

Seventeen specimens (in alcohol), from Simalur Island. While it is quite possible that these do not represent true *Myotis muricola*, I am unable to distinguish them in the absence of material for comparison. They closely agree with specimens from Trong, Lower Siam.

Measurements of Myotis muricola.

Locality.	Number.	Sex.	Total length.	Tail.	Tibia.	Foot.	Forearm.	Thumb.	Second digit.	Third digit.	Fourth digit.	Fifth digit.	Ear from meatus.	Ear from crown.
			mm	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*
Simalur Island	114230	Female, adult	78	36	15	7	35	6.4	29	61	50	46	13	11
Do	114231	do	73	35	15	8	36	7	30	60	49	45	12	10
Do	114232	do	75	37	14	7	37	5	32	63	52	47	14	12
Do	114235	do	73	37	15	7	34	5	30	62	48	45	14	11
Do	114237	do	75	37	16	8	36	5.4	31	61	50	45	15	11
Do	114240	Female, young	52	23	10	7	27	5	19	35	30	33	10	8.4
Do	114241	Female, adult	75	37	15	7	36	5	31	61	48	43	14	10
Do	114244	Female, young	65	28	14	7	31	6	22	44	37	35	11	9
Do	114245	Female, adult	79	37	15	7.4	34	6	32	65	50	45	15	13
Do	114246	do	80	37	15	7	36	6	31	62	52	48	13	10
Do	114233	Male, adult	75	35	15	8	35	5	31	60	48	44	13	10
Do	114234	do	71	31	15	8	34	7	29	59	47	43	11	9
Do	114236	do	76	35	15	7	34	6	28	60	49	46	14	11
Do	114238	Male, young	55	22	11	7	26	6	17	35	28	26	10	8
Do	114239	do	65	37	13	7	31	6	25	49	40	38	12	10
Do	114242	Male, adult	75	35	16	7	35	5.6	29	57	45	42	12	10
Do	114243	do	72	33	15	8	35	6	30	58	46	42	13	10

Family EMBALLONURIDÆ.

EMBALLONURA PENINSULARIS Miller.

1898. *Emballonura peninsularis* Miller, Proc. Acad. Nat. Sci. Philadelphia, 1898, p. 323, July 25, 1898; Trong, Lower Siam.

Six specimens (in alcohol) from Pulo Babi.

Measurements of Emballonura peninsularis.

Locality.	Number.	Sex.	Total length.	Tail.	Tibia.	Foot.	Forearm.	Thumb.	Second digit.	Third digit.	Fourth digit.	Fifth digit.	Ear from meatus.	Ear from crown.
			mm	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*
Pulo Babi	114274	Female adult	50	10	17	8	42	8	35	62	42	44	11	10
Do	114279	do	57	13	16	11	41	8	37	69	49	46	13	10
Do	114275	Male adult	54	13	16	10	44	8	35	65	47	44	12.4	11
Do	114276	do	53	11	15	10	....	8	33	68	45	44	12	10
Do	114277	do	57	13	17	9	43	7	37	66	48	45	14	11
Do	114278	do	53	11	17	9	45	8	35	66	47	46	12	10

Family NYCTERIDÆ.

MEGADERMA SPASMA (Linnæus).

1758. [*Vespertilio*] *spasma* LINNÆUS, Syst. Nat., I, 10th ed., p. 32; "Asia."

Nine specimens: Pulo Siumat, off Simalur Island, 3 (2 in alcohol); Pulo Lasia, 4 (2 in alcohol); Pulo Babi, 2 (in alcohol).

Measurements of Megaderma spasma.

Locality.	Number.	Sex.	Total length.	Tail.	Tibia.	Foot.	Forearm.	Thumb.	Second digit.	Third digit.	Fourth digit.	Fifth digit.	Ear from meatus.	Ear from crown.
			mm	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*
Pulo Siumat	[a] 114227	Female adult	75	....	32	18	58	19	50	105	78	83	39	31
Do	114228	....do	69	5	33	15	59	19	53	110	79	82	36	30
Do	114229	....do	68	3	30	17	60	17	51	109	81	85	36	30
Pulo Lasia	[a] 114249	Male adult	80	....	32	19	59	19	56	101	81	81	37	30
Do	114252	....do	77	2	29	20	58	20	53	108	82	85	37	30
Do	[a] 114250	Female adult	85	....	33	19	60	19	55	107	84	83	36	29
Do	114251	....do	70	4	34	19	61	19	55	110	84	88	38	31
Pulo Babi	114272	Male adult	78	2	31	19	59	18	53	108	80	83	36	28
Do	114273	Female adult	79	....	33	19	....	20	53	112	85	88	37	30

[a] Skin.

Family PTEROPODIDÆ.

CYNOPTERUS TITTHÆCHEILUS (Temminck).

1827. *Pteropus titthæcheilus* TEMMINCK, Monogr. de Mamm., I, p. 198; Buitenzorg, Java.

1902. *Cynopterus titthæcheilus* STONE and REHN, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 136, June 4, 1902.

Twenty-four, from the following localities: Pulo Babi, 3 (2 in alcohol); Tapanuli Bay, Sumatra, 21 (19 in alcohol). They closely agree with specimens of true *Cynopterus titthæcheilus* from Java, and are readily distinguishable from the *C. montanoi* of the southern extremity of the Malay Peninsula by their larger general size, and particularly by their large skulls and heavy teeth. As in *C. montanoi* the ears show no indication of a whitish border.

The original description of this species was based on material from Java, Sumatra, and Siam. It therefore included *Cynopterus montanoi*. As Temminck expressly states that most of his specimens were taken at Buitenzorg, Java, it is safe to regard this as the type locality.

Measurements of Cynopterus titthæcheilus.

Locality.	Number.	Sex.	Total length.	Tail.	Tibia.	Foot.	Forearm.	Thumb.	Second digit.	Third digit.	Fourth digit.	Fifth digit.	Ear from meatus.	Ear from crown.
			mm	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*
Pulo Babi	[a] 114269	Female adult	103	8	25	15	65	27	46	108	85	85	13	10
Do	114271	do	93	8	27	15	66	26	44	112	88	86	17	16
Do	114270	Male adult	95	6	25	15	67	25	42	112	87	86	18	15
Tapanuli Bay	[a] 114466	do	113	10	27	18	68	28	46	110	86	89	15	14
Do	114486	Male, young	87	9	21	16	60	28	43	93	74	74	17	15
Do	[a] 114467	Female adult	110	8	28	17	66	29	46	107	88	86	16	13.4
Do	114468	Female, young	86	10	24	15	62	25	41	97	79	78	17	14
Do	114469	Female adult	96	10	24	14	61	28	43	109	83	83	18	16
Do	114470	do	90	10	23	15	65	26	41	106	81	80	17	15
Do	114471	do	94	9	24	17	67	26	44	110	85	85	18	16
Do	114472	do	93	9	24	15	65	27	44	109	83	81	19	17
Do	114473	Female, young	85	9	23	17	63	22	43	103	78	77	18	15
Do	114474	Female adult	93	8	25	14	66	26	43	110	85	83	18	15
Do	114475	do	89	9	24	16	65	26	45	110	89	90	20	17
Do	114476	do	90	10	26	15	68	26	43	110	83	82	18	17
Do	114477	do	92	10	25	16	66	27	42	107	86	80	18	15
Do	114478	do	93	10	23	15	64	25	42	103	79	78	16	15
Do	114479	do	90	9	22	18	66	28	44	109	83	80	19	15
Do	114480	do	96	10	26	16	67	29	46	107	85	83	17	16
Do	114481	do	95	10	23	17	66	29	48	111	85	85	18	15
Do	114482	Female, young	88	7	23	15	63	25	41	100	84	79	18	14
Do	114483	Female adult	100	9	25	14	64	27	41	107	82	81	17.6	15
Do	114484	Female, young	85	8	26	15	60	27	40	104	78	77	17	14
Do	114485	do	88	8	24	16	64	26	45	105	83	83	19	16

[a] Skin.

Family NYCTICEBIDÆ.

NYCTICEBUS MALAIANUS (Anderson).

1881. [*Nycticebus tardigradus*] var. *malaiana* ANDERSON, Catal. Mamm. Indian Mus., I, p. 95; Malacca.

1902. *Nycticebus coucang malaianus* STONE and REHN, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 139, June 4, 1902.

An adult male was taken at Tapanuli Bay on March 20, 1902. Measurements: Total length, 328; head and body, 312; tail vertebræ, 16; hind foot, 65.

This specimen has been examined by Mr. Stone and Mr. Rehn, who write me that they consider it "undoubtedly *malaianus*." Although Anderson mentions no type specimen in his original description of the form, the stuffed adult male and its skull which heads his list of material (p. 96) may be regarded as the type. This was collected at Malacca.

Family CERCOPITHECIDÆ.

MACACUS NEMESTRINUS (Linnæus).

1766. [*Simia*] *nemestrina* LINNÆUS, Syst. Nat., I, 12th ed., p. 35; Sumatra.

Two pig-tailed macaques taken at Tapanuli Bay, Sumatra, were the only individuals of the species observed. For measurements, see table, page 477.

MACACUS "CYNOMOLGUS." Auct.

Macacus cynomolgus AUCT., not *Simia cynomolgus* LINNÆUS.

Seven specimens of the common crab-eating macaques were obtained, three on Pulo Tuangku, two on Pulo Mansalar, and two at Tapanul Bay, Sumatra. For measurements, see table, page 477.

MACACUS FUSCUS, new species.

Type.—Old male (skin and skull). Cat. no. 114164, U.S.N.M Collected on Simalur Island, northwestern Sumatra, November 20 1901, by Dr. W. L. Abbott. Original number, 1348.

Characters.—Similar to *Macacus umbrosus*[a] of the Nicobar Islands but smaller and with relatively shorter tail.

Color.—Type: Upperparts and outer surface of limbs blackisl brown with a paint tinge of drab, each hair drab at base and with a wood-brown annulation 2 to 4 mm. in width near tip. As the fur i of a soft, silky quality, the exact effect of the two colors varies con siderably with reflection of light and with disarrangement of hairs, bu the wood-brown is everywhere very distinct though not in excess o the dark underlying brown. Underparts and inner surface of limbs light bluish gray (very nearly Ridgway's No. 8). This color suffuse cheeks and region surrounding ears. Tail like back above, but wit the light annulations very indistinct, like belly below and at tip.

Skull and teeth.—The skull and teeth resemble those of *Macacu umbrosus* except for their much smaller size.

Measurements.—External measurements of type: Total length, 92(head and body, 470; tail vertebræ, 450; hind foot, 125 Average c five males from the type locality: Total length, 939 (905–985); hea and body, 478 (460–495); tail vertebræ, 467 (435–490); hind foot, 12 (118–130). For details see table, page 477.

Cranial measurements of type: Greatest length (exclusive of inc sors), 122 (134);[b] basal length, 93 (102); basilar length, 87 (96); lea palatal length, 49 (57); palatal breadth (between front molars), 21 (25 zygomatic breadth, 83 (90); mastoid breadth, 64 (71); greatest breadt of brain case above roots of zygomata, 60 (61); least breadth of bra case immediately behind orbits, 38.6 (39); orbital breadth, 61 (67 least distance from orbit to alveolus of inner incisor, 44 (49); greate depth of brain case (exclusive of sagittal crest), 45 (50); mandibl 82 (97); greatest depth of ramus, 19 (19.6); maxillary tooth ro (exclusive of incisors), 40 (44.6); mandibular tooth row (exclusive incisors), 45 (50); crown of middle upper molar, 7.4 by 7 (8.8 by 9 crown of middle lower molar, 8 by 6 (8.2 by 7.4).

Specimens examined.—Ten, eight from Simalur Island and two fro Pulo Lasia.

[a] Miller, Proc. U. S. Nat. Mus., XXIV, May 28, 1902, p. 789.

[b] Measurements in parentheses are those of the type of *Macacus umbrosus*, a you adult male, with unworn teeth.

Remarks.—In color and size the specimens from Simalur Island are very constant, presenting no variation worthy of note. In the two from Pulo Lasia the tail is considerably longer, making the proportions essentially the same as in *Macacus umbrosus*. They are readily separable from the Nicobar species, however, by their much smaller skulls.

Measurements of Macacus.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.
				mm.	*mm.*	*mm.*	*mm.*
Macacus nemestrinus.	Tapanuli Bay	114502	Female adult...	690	480	210	160
Do..............	.....do............	114503	.....do..........	660	490	170	143
Macacus "cynomolgus."	.....do............	114505	Male adult.....	922	452	570	127
Do..............	.....do............	114506	.....do..........	973	453	520	130
Do..............	Pulo Mansalar....	114559	.....do..........	....	445	....	127
Do..............	.....do............	114560	.....do..........	940	440	500	125
Do..............	Pulo Tuangku....	114408	.....do..........	955	420	535	125
Do..............	.....do............	114409	.....do..........	953	423	530	125
Do..............	.....do............	114410	.....do..........	905	425	480	117
Macacus fuscus	Pulo Lasia........	114247	.....do..........	960	440	520	125
Do..............	.....do............	114248	.....do..........	1,025	470	555	130
Do..............	Simalur Island ...	114162	Female adult...	915	440	475	115
Do..............	.....do............	114165	.....do..........	830	420	410	110
Do..............	.....do............	114166	.....do..........	830	410	420	110
Do..............	.....do............	114163	Male adult.....	905	470	435	118
Do..............	.....do............	114164	.....do..........	985	495	490	128
Do..............	.....do............	114167	.....do..........	940	495	445	125
Do..............	.....do............	[a] 114168	.....do..........	920	470	450	125
Do..............	.....do............	114169	.....do..........	945	460	485	130

[a] Type.

PRESBYTES [a] SUMATRANUS (Müller and Schlegel).

1839–1844. *Semnopithecus sumatranus* MÜLLER and SCHLEGEL, Verhandel. over de natuurlijke Geschiedenis der Nederl. overzeesche bezittingen, p. 73; Sumatra.

Four specimens taken at Tapanuli Bay, Sumatra, are essentially identical with those previously collected by Dr. Abbott on the Indragiri River, eastern Sumatra.[b] For measurements see table, page 477.

PRESBYTES CRISTATUS (Raffles).

1822. *Simia cristata* RAFFLES, Trans. Linn. Soc. London, XIII, p. 244; Bencoolen, Sumatra.

One skin from Loh Sidoh Bay and five from Tapanuli Bay, Sumatra. For measurements see table:

Measurements of Presbytes.

Name.	Locality.	Number.	Sex.	Total length.	Head and body.	Tail.	Hind foot.
				mm.	*mm.*	*mm.*	*mm.*
Presbytes sumatranus.	Tapanuli Bay	114507	Male adult.....	1,270	510	760	160
Do..............	.....do............	114508	Female adult...	1,230	500	730	170
Do..............	.....do............	114509	.....do..........	1,260	515	745	165
Do..............	.....do............	114510	.....do..........	1,215	455	760	165
Presbytes cristatus....	Loh Sidoh Bay ...	114160	.....do..........	1,200	500	700	145
Do..............	Tapanuli Bay	114512	Female young..	950	400	550	132
Do..............	.....do............	114513	Female adult...	1,190	530	660	150
Do..............	.....do............	114515	.....do..........	1,130	465	665	145
Do..............	.....do............	114514	Male adult.....	1,290	540	750	163
Do..............	.....do............	114516	.....do..........	1,295	510	755	163

[a] *Presbytes* Eschscholtz, Kotzebue's Entdeckung's Reise, III, 1821, p. 196, type *P. mitratus* Eschscholtz, antedates *Semnopithecus* F. Cuvier, Des Dents des Mammifères, 1825, pp. 14, 247, the first publication of the more familiar name in Latin form.

[b] See Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 159, June 11, 1902.

Family SIMIIDÆ.

HYLOBATES AGILIS F. Cuvier.

1821. *Hylobates agilis* F. Cuvier, Hist. Nat. des Mammifères, III, Pts. 32 and 33 September, 1821; Sumatra.

1902. *Hylobates hoolock* Miller, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 159 June 11, 1902.

Three specimens from Tapanuli Bay, Sumatra. For measurements see table, page 478. This animal is the same as that from the Indragiri River, eastern Sumatra, which I recently recorded as *Hylobates hoolock*. It is undoubtedly the *H. agilis* of F. Cuvier, some of the light-colored specimens almost exactly matching the figure in the original account of the species.

SYMPHALANGUS SYNDACTYLUS (Raffles).

1822. *Simia syndactyla* Raffles, Trans. Linn. Soc. London, XIII, p. 241; Bencoolen, Sumatra.

Four adults were taken at Tapanuli Bay, where the animal is common.

Measurements of Hylobates and Symphalangus from Tapanuli Bay.

Name.	Number.	Sex.	Total length.	Hind foot.
			mm.	*mm.*
Hylobates agilis	114499	Male adult	470	13[illegible]
Do	114500	do	445	13[illegible]
Do	114501	Female adult	415	12[illegible]
Symphalangus syndactylus	114494	do	470	14[illegible]
Do	114497	do	500	15[illegible]
Do	114495	Male adult	510	15[illegible]
Do	114496	do	525	15[illegible]

NOTES ON THE FAUNA OF THE LOCALITIES VISITED.

Lists of the mammals observed at the different collecting stations follow, together with the collector's field notes.

Loh Sidoh Bay, Sumatra (November 5 to 8, 1901).

Sciurus albescens.—Common in jungles and cocoanut plantations.

Mus lingensis. Trapped on a low, jungle-covered hill east of the bay

Tupaia ferruginea Raffles. Found in dense jungle by the seashore.

Presbytes maurus.—Shot in dense jungle by the seashore.

"Saw tracks of tiger, *Cervus equinus*, pig, kijang, etc., but did not secure any specimens."

Simalur Island (November 16, 1901, to January 2, 1902).

Sus vittatus.—Pigs are very common. One meets with their tracks and "diggings" everywhere; but except where sago is being made

they are hard to catch sight of. An adult female (No. 114177) was killed in the forest while feeding on the trunk of a sago palm. Others were killed in clearings and among the mangroves on the shore.

Mus simalurensis.—

Mus surdus.—No rats were caught in the forest, though many traps were set there. Afterwards the traps were moved to stumps, dead tree trunks, and stony, weedy places in paddy fields with much better results. A few of the larger kind (*Mus simalurensis*) were caught in these situations, and they were common in heavy jungle on Pulo Siumat, 5 miles offshore. The smaller species was common in the paddy fields, and also about houses. Some were found in the stomachs of snake eagles and also in snakes.

Paradoxurus hermaphroditus.—Common. Only once seen in the jungle, but natives caught several; said to be very destructive to poultry.

Myotis muricola.—Brought in by natives at Sibaboh Bay, where they were caught in hollow trees.

Megaderma spasma.—Obtained in some small caves at the seashore on Pulo Siumat.

Pteropus sp.—Called by the natives "tupai," the Malay name for squirrel. A "camp" existed on Pulo Asu and two others were said to be on Pulo Siumat. Although frequently seen flying about in the evening, no specimens were secured.

Macacus fuscus.—Common. Has the usual habits of *Macacus*. The only monkey on the island.

Pulo Lasia (January 4 to 7, 1902).

Mus simalurensis.—Common in the jungle.

Megaderma spasma.—A bunch of four were shot while hanging under a projecting rock in the jungle.

Macacus fuscus.—Common. Is not found on the neighboring Pulo Babi.

Pulo Babi (January 7 to 14, 1902).

Sus vittatus.—Although no pigs occur on Pulo Lasia they are abundant on Pulo Babi, but are not easily seen in the dense jungle. Only three were shot. Their "sarongs" or nests were very common in the jungle. These are generally made of the leaves of a small palm and resemble little haycocks. The pig of Babi appears to be different from that of Simalur. It is considerably larger.

Mus simalurensis.—A large gray rat was not uncommon, but all the specimens trapped were so cut to pieces by crabs that no skins could be saved. Several skulls, however, were preserved.

Emballonura peninsularis.—No notes.

Cynopterus titthæchæilus.—Common. Found hanging by day from the midribs of the leaves of an areca palm.

PULO BANGKARU, BANJAK ISLANDS (January 16 to 21, 1902).

No pigs or monkeys were seen, and the natives say that none occur. A number of *Pteropus* were seen, and at least two kinds of smaller bats, but none were obtained. My Malay sailing master said that he saw a red "tupai" on the ground. It was probably the form of *Tupaia tana* afterwards taken on Pulo Tuanku.

Tragulus brevipes.—Several seen; only one taken.

Sciurus pretiosus.—Common.

Sciurus bancarus.—Very common.

Mus firmus.—

Mus fremens.—

Mus lingensis. Rats were very plentiful, but land and hermit crabs abounded to such an extent that trapping was difficult and many of the specimens caught were ruined.

PULO TUANGKU, BANJAK ISLANDS (January 22 to February 5, 1902).

Tragulus russeus.—Very common. Am not certain whether there are one or two forms. Three males weighed over 5 pounds each, bu none of the females were so large. Now in *Tragulus* the female i considerably larger than the male; but no correspondingly larg females were obtained among the thirty or more that I examined Most of the females were pregnant.

Sus vittatus.—A rather small form. Common, but only one femal and an immature male obtained.

Sciurus ubericolor.—Common.

Ratufa palliata.—

Ratufa femoralis.—Both very common and very noisy. Often see together in the same tree. When alive the brown one (*femoralis* appears smaller than the other.

Rhinosciurus laticaudatus.—A female was caught in a rat trap a Ujong Tumbaga.

Mus firmus.—

Mus fremens.—

Mus asper.—

Mus lingensis.—All four species of *Mus* were common.

Lenothrix canus.—Only one taken.

Galeopithecus volans.—Common.

Macacus "cynomolgus."—Common. A small form similar to that o Sumatra.

PULO MANSALAR, AT ENTRANCE TO TAPANULI BAY (March 2 to 1 1902).

A monkey, apparently identical with the *Presbytes maurus* of th mainland, was observed, but no specimen could be secured. It w shy and not very common. The tracks of pigs were abundant, b

none of the animals themselves were seen. Natives reported *Galeopithecus* common, and also said that no musangs occur.

Tragulus amœnus.—Two were brought in by natives.

Tragulus jugularis. Common. About thirty were brought in by natives. Three Nias men with two dogs went to the northwest end of the island, and returned in two days with fourteen napu, so the animals must be very plentiful.

Sciurus saturatus.—Common.

Sciurus mansalaris.—Very common. Crepuscular, but a few may be seen at all hours.

Ratufa nigrescens.—Common, but neither as plentiful nor as noisy as the species of Pulo Tuangku.

Mus domitor.—

Mus fremens.—

Mus catellifer.—All three species of rats were common.

TAPANULI BAY, NORTHWESTERN SUMATRA (February 12 to 28 at Lobo Pandan Bay, and March 16 to 29 at Jaga Jaga).

No elephants are in the immediate vicinity, but they are said to be common only a few miles away. A rhinoceros is said to have come close to the village while I was at Lobo Pandan.

Rusa.—A female or young male seen.

Cervulus.—Heard at Lobo Pandan. One seen.

Tragulus kanchil.—Very common.

Tragulus napu.—Several snared and brought in, but all were immature except one fine male. If this is typical *napu*, as it probably is, it is a different animal from any that I have heretofore obtained.

Sus.—None seen, but their tracks were everywhere plentiful.

Sciurus vittatus.—Common.

Sciurus tenuis.—Common.

Sciurus erebus.—Generally common, but less so than the last. A good many met with in the mangroves, and particularly in the cocoanuts at Jaga Jaga village.

Ratufa palliata.—Not very common. Heard several times at Lobo Pandan. A pair often seen and fired at unsuccessfully on Gunong Kebong, where a half-grown female was finally shot.

Mus firmus.—

Mus fremens.—

Mus lingensis.—All three rats were common.

Mus asper.—Only one taken.

Trichys macrotis.—Several caught by Malays on Bukit Sawa.

Herpestes brachyurus. A pair were caught by Malays in a jerat (snare) on Bukit Sawa.

Paradoxurus.—No skins. A half-grown female brought to me alive is now (April 6) well and growing fast. While it does not look

like the *P. hermaphroditus* of the peninsula, it closely resembles the form found on Simalur; so the latter may have been introduced.[a] The Malays often keep musangs as pets.

Hemigale hardwickii. One snared by Malays on Bukit Sawa.

Aonyx cinerea.—A female snared on Bukit Sawa. It is apparently adult, though weighing only 5¾ pounds.

Gymnura gymnura. One caught alive by a Malay on Bukit Sawa.

Tupaia ferruginea. Apparently not common. Three specimens obtained at Lobo Pandan.

Pteropus sp. Often seen flying over Jaga Jaga. Two were shot, but fell into the water and were lost. *Pteropus* usually sinks in water unless very fat.

Cynopterus titthæcheilus.—A bunch of twenty females were found hanging on a cocoanut leaf at Jaga Jaga. All were killed at one shot. A male found hanging alone on another tree about 20 feet away was also shot.

Nycticebus malaianus.—One brought in alive. Malay name, "kon-kong." The animal is much used in medicine and magic.

Presbytes sumatranus.—Not as common as *P. maurus*, and keeps more strictly to the hills and heavy forests. Local name, "boóro."

Presbytes maurus.—Common, especially among the mangroves. Local name, "chinko."

Macacus nemestrinus.—Malay name, "broh," but locally called "bëróh." Met with a number of times, but only two, both females, shot. These short-tailed *Macacus* are always shy and hard to get. Did not observe them in captivity in Sumatra, although I have seen many in other places trained to climb for cocoanuts. A well-trained broh is said to sell for $20 to $25 (Straits dollars) in the Straits Settlements.

Macacus "cynomolgus."—Malay name Krah, from its call. About Tapanuli the local name is Káro. Very common. Apparently a rather small form. Some few males seem to grow to a large size. I shot one very large male, but he tumbled into the river and sank immediately. I do not think that more than one male in a hundred ever reaches this large size—probably 15 or 16 pounds. It is the same with *M. cynomolgus* everywhere.

Hylobates agilis. Common; some are pale brown and some black. A brown female (No. 114501), killed on February 22, had a black husband and a black baby. Gibbons are monogamists.

Symphalangus syndactylus. Common. Their extraordinary cries heard everywhere about Tapanuli Bay, also at Tapat Tuan, 140 miles farther up the coast. A new born young, killed by the same shot

[a] In a letter dated September 26, 1902, Dr. Abbott writes that this musang, now nearly adult, has grown to resemble in all respects the common *P. hermaphroditus* of the Malay Peninsula.

which killed its mother, was naked except on its scalp. A few days after another female was shot. This had a baby about a month old, which is now (April 6) well covered with hair and has cut all its milk incisors. It thrives on condensed milk and bananas and is too affectionate to be an altogether agreeable pet. A later note says that this siamang died of diarrhea on April 14.

Simia.—The orang utan exists, but not abundantly, about Tapanuli Bay. Two miles up the Jaga Jaga River some nibong palms were seen that had been broken off by orangs, and also an old sarong (shelter), but the traces were old. There were said to be more a few miles farther inland, particularly up the Berdiri River. The natives say they always go about in pairs. This is probably true, as all the siamang I met with were in pairs, and all gibbons, as far as I know, are monogamous. Often one meets with two or more pairs on a favorite fruit tree, and, of course, they have young ones with them; but they never go in gangs like *Macacus* and *Pushytes*, and it is usual for a pair to be alone or with one baby.

EXPLANATION OF PLATES.

Plate XVIII.

Lenothrix canus, Type.

Figs. 1–3, skull (natural size); fig. 4, crowns of lower molars (about × 4); fig. 5, crowns of upper molars (about × 4).

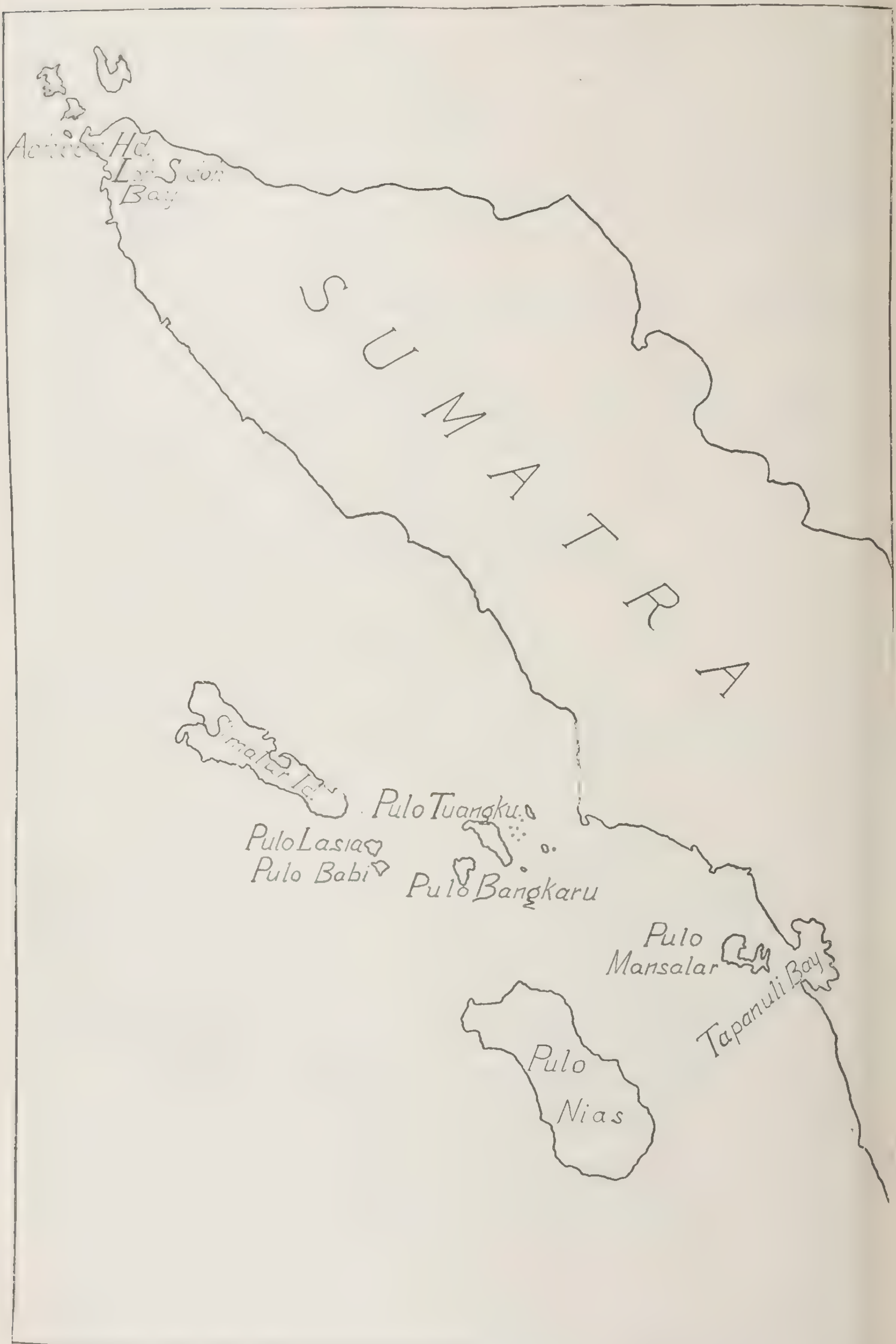
Plate XIX.

Ratufa lænata R. palliata.

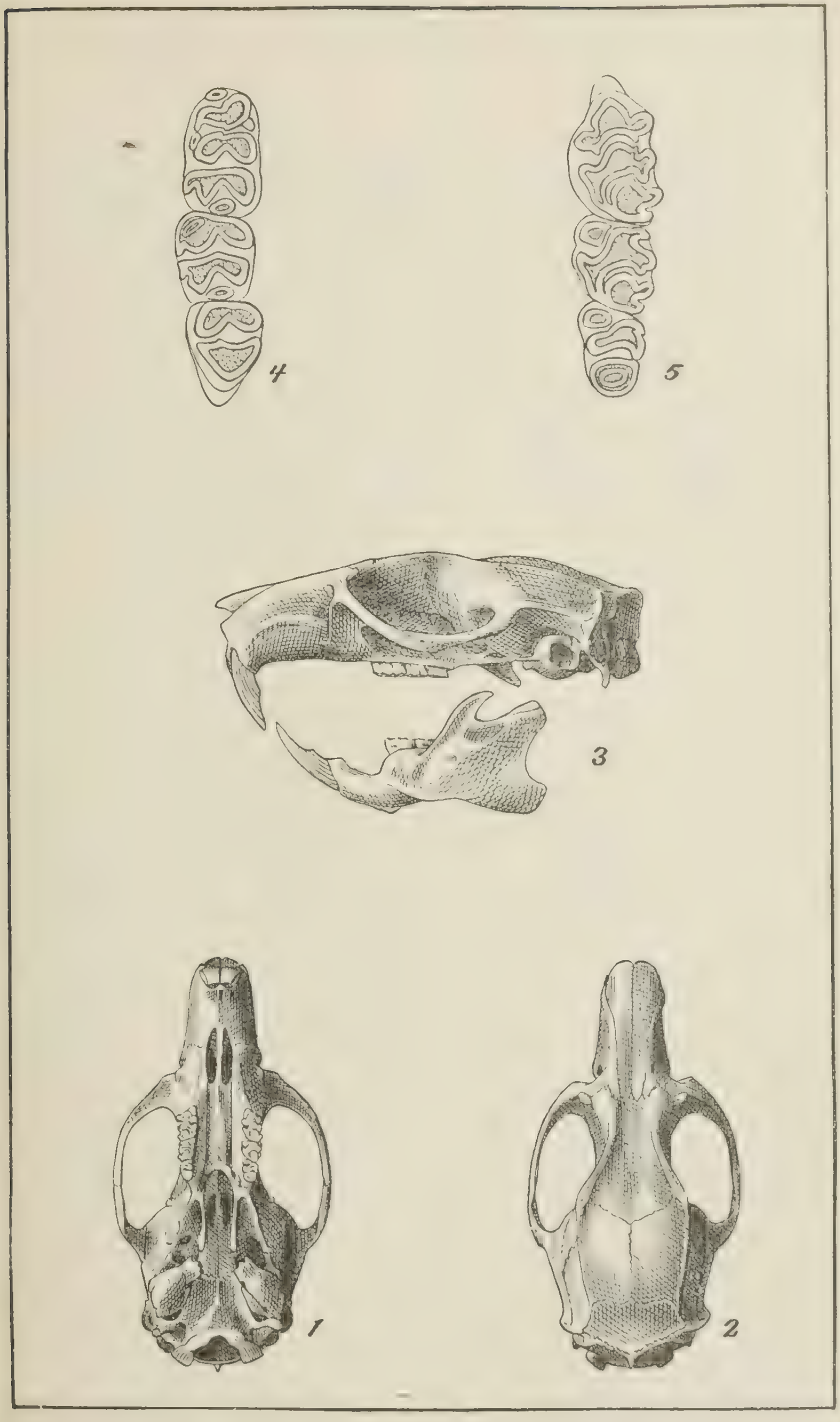
Figs. 1–9, posterior termination of nasals and premaxillaries in 9 skulls of *Ratufa lænata;* figs. 10–12, the same in 3 skulls of *R. palliata;* figs. 13–21, anterior termination of maxillaries in 9 skulls of *R. lænata;* figs. 22–24, the same in 3 skulls of *R. palliata* (all about × 1.75).

Figs. 1 and 13, male, No. 114352.	Figs. 7 and 19, male, No. 114357.
2 and 14, female, No. 114349.	8 and 20, male, No. 114350. Type.
3 and 15, male, No. 114354.	9 and 21, female, No. 114347.
4 and 16, female, No. 114355.	10 and 22, —, No. 114003.
5 and 17, male, No. 114346.	11 and 23, —, No. 114004.
6 and 18, male, No. 114356.	12 and 24, male, No. 113162. Type.

Nos. 1–9, 13–21, from Pulo Tuanku; Nos. 10–11, 22–23, from Sumatra, exact locality not known; Nos. 12 and 24, from the Indragiri River, eastern Sumatra.

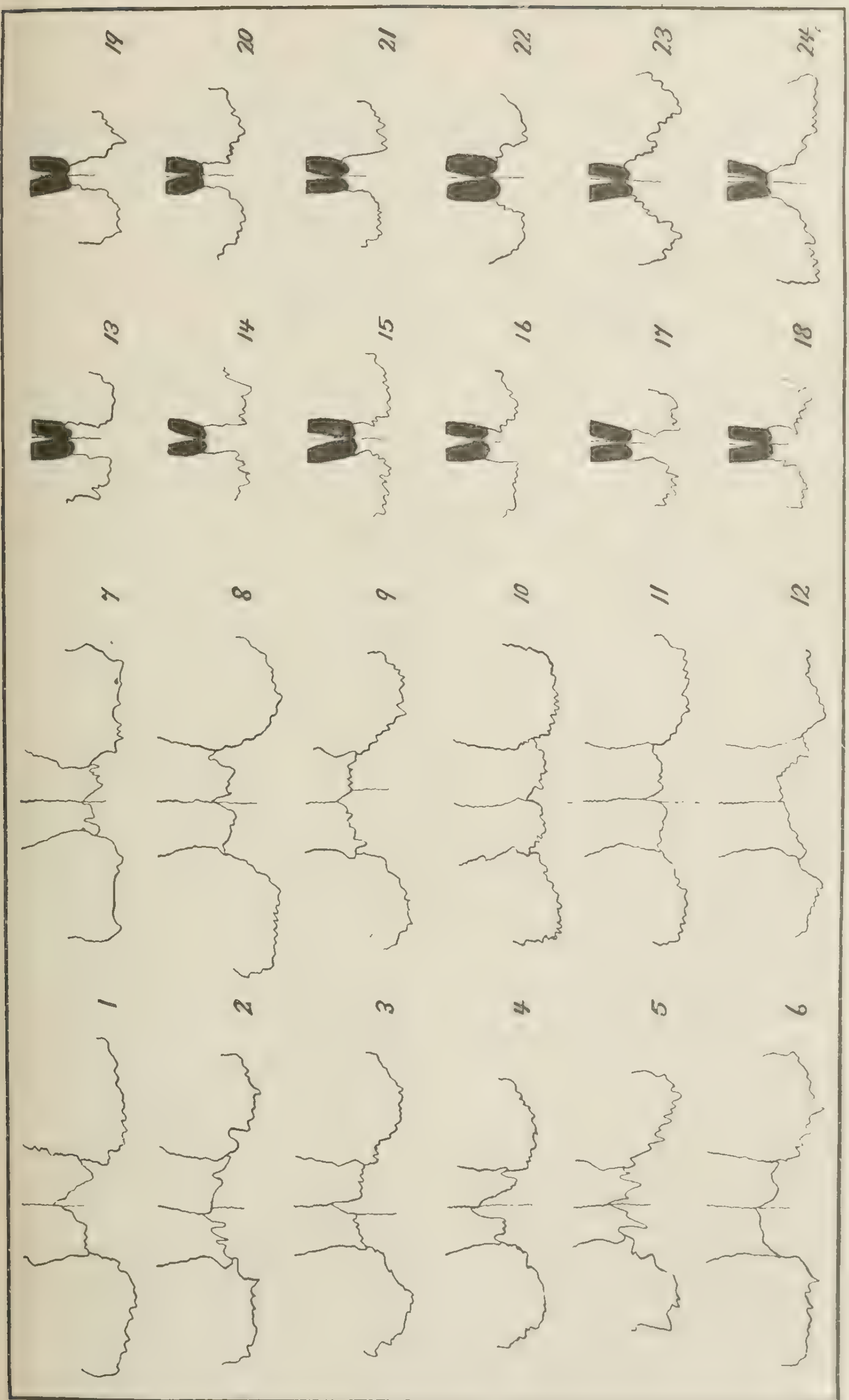


NORTHWESTERN SUMATRA AND ADJACENT ISLANDS.



SKULL AND TEETH OF LENOTHRIX CANUS, TYPE.

FOR EXPLANATION OF PLATE SEE PAGE 483.



PART OF INTERORBITAL REGION AND PALATE IN RATUFA PALLIÆTA AND R. LANATA.

FOR EXPLANATION OF PLATE SEE PAGE 483.

BIRDS COLLECTED BY DR. W. L. ABBOTT ON THE COAST AND ISLANDS OF NORTHWEST SUMATRA.

By Charles W. Richmond,
Assistant Curator, Division of Birds.

The collection noticed in the following pages was received by the United States National Museum in July, 1902. It consists of about 450 specimens, representing nearly 140 species, many of which are of great interest, and was made by Dr. Abbott in the course of a five months' cruise on the northwest coast of Sumatra. This untiring traveler sailed from Singapore in the latter part of October, 1901, for the purpose of visiting certain zoologically unexplored islands on the west side of Sumatra. His first stopping place was Loh Sidoh Bay, a few miles south of Acheen Head, where, owing to the unfriendliness of the natives, work was carried on for a few days only (November 5–8). Simalur (Babi, Simalu, or Si Malu of some maps), a hilly and well-wooded island about 55 miles in length, was next visited. Here several weeks (November 16, 1901–January 3, 1902) were very profitably passed at various points (Telok Dalam, November 17–December 1; Sibaboh Bay, December 8–17; Sigoeli River, December 19; Pulo Asu, December 25–26; Pulo Siumat, December 27–30; and Labuan Badjau Bay, January 1–3) on the Sumatran side. Early in January Dr. Abbott sailed to Pulo Lasia and Pulo Babi, small islets lying 14 miles southeast of Simalur, and separated from one another by a narrow strait only 1¼ miles wide. Pulo Lasia is about 2½ miles long by 2 miles wide, while Pulo Babi is even smaller. Both are uninhabited, low, wooded islands (the "Flat Islands" of some maps) of coral formation. After a few days (January 4–14) spent here, the Banjak Islands were visited. This group consists of Pulo Bangkaru (or Beng Karu), Pulo Tuangku (or Tunangku), and about four unnamed islets. Pulo Bangkaru, heavily forested, with an area of about 20 square miles, was first visited (January 16–22), and later Pulo Tuangku (January 22–February 6), which is 17 miles long by about 5 miles wide. On the latter, birds were found in abundance, both species and individuals outnumbering those observed on Simalur. Many species additional

to those given in the list at the end of this paper were seen, but the collector writes that "no large parrots, hornbills, or barbets were seen or heard, and no drongos or orioles were noticed;" also, "no partridges or pheasants were found on any of the islands visited." From the Banjak Islands Dr. Abbott proceeded to Tapanuli Bay (February 11–March), on the coast of Sumatra, where he remained for six weeks, visiting various points on the bay, including a short trip to Pulo Mansalar, situated about 7 miles from the mainland. Tapanuli Bay and Pulo Mansalar are both heavily forested, and birds were abundant at the former place, but the time spent here was mainly occupied in collecting mammals.

The birds enumerated below are referable to 152 species, of which 19 are believed to be new,[a] namely: *Macropygia simalurensis*, *Spilornis abbotti*, *Pisorhina umbra*, *Palæornis major*, *Psittinus abbotti*, *Pelargopsis simalurensis*, *P. sodalis*, *Thriponax parvus*, *Macropteryx perlonga*, *Cyanoderma fulviventris*, *Stachyris banjakensis*, *Malacopteron notatum*, *Hypothymis abbotti*, *H. consobrina*, *Tchitrea procera*, *Graucalus babiensis*, *G. simalurensis*, *Campephaga compta*, and *Oriolus mundus*.

All measurements in this list are in millimeters. Those of total length were taken from the fresh bird by the collector, and have been reduced from English inches to millimeters.

Family CHARADRIIDÆ.

CHARADRIUS DOMINICUS FULVUS (Gmelin).

[*Charadrius*] *fulvus* GMELIN, Syst. Nat., I, Pt. 2, 1788, p. 687 (Tahiti).

Three specimens from Simalur. Length, 235–248 mm. "Feet slaty."

"Common about river mouths and on the padangs."

OCHTHODROMUS GEOFFROYI (Wagler).

Ch[*aradrius*] *geoffroyi* WAGLER, Systema Avium, I, 1827 [p. 61], (Pondichery; Java).

Three examples from Simalur, where they were common.

One specimen, a female, has an unbroken dusky band across the chest.

OCHTHODROMUS PYRRHOTHORAX (Gould).

Charadrius pyrrhothorax TEMMINCK MS., GOULD, Birds of Europe, IV (Pt. 20), 1837 [p. 299], pl. CCXCIX ("Russia").

Two females from Simalur. Length, 191–197 mm.

"Common on the seashore, in company with the last."

[a] Eight of these were described in Proc. Biol. Soc. Washington, XV, 1902, pp. 187–190.

Family SCOLOPACIDÆ.

GALLINAGO STENURA (Bonaparte).

Scolopax stenura "KUHL" BONAPARTE, Ann. Stor. Nat. Bologna, IV, 1830, p. 335 (Sunda Islands).

One pair from Simalur. Length, 267 mm.
"Common in the paddy fields and in the wet padangs (meadows)."

TOTANUS TOTANUS EURHINUS Oberholser.

Totanus totanus eurhinus OBERHOLSER, Proc. U. S. Nat. Mus., XXII, 1900, p. 207 (Lake Tsomoriri, Ladak).

"A few seen along the Sigoeli River," in Simalur.

ACTITIS HYPOLEUCOS (Linnæus).

[*Tringa*] *hypoleucos* LINNÆUS, Syst. Nat., 10th ed., Pt. 1, 1758, p. 149 (Europe).

"Common" in Simalur.

LEIMONITES RUFICOLLIS (Pallas).

Trynga ruficollis PALLAS, Reise Russischen Reichs, III, 1776, p. 700 ("circa Lacus salsos Dauuriae campestris").

A single female, from Simalur.

NUMENIUS ARQUATUS (Linnæus).

[*Scolopax*] *arquata* LINNÆUS, Syst. Nat., 10th ed., Pt. 1, 1758, p. 145 (Europe).

A female from Pulo Tuangku. Length, 559 mm.

NUMENIUS PHÆOPUS (Linnæus).

[*Scolopax*] *phæopus* LINNÆUS, Syst. Nat., 10th ed., Pt. 1, 1758, p. 146 (Europe).

One female, from Simalur, where it was "common." Length, 445 mm.

ARENARIA INTERPRES (Linnæus).

[*Tringa*] *interpres* LINNÆUS, Syst. Nat., 10th ed., Pt. 1, 1758, p. 148 ("Europa & America septentrionali").

A female was collected December 20, on Simalur. Length, 235 mm.

Family ŒDICNEMIDÆ.

ESACUS MAGNIROSTRIS (Vieillot).

Œdicnemus magnirostris VIEILLOT, Nouv. Dict. d'Hist. Nat., XXIII, 1818, p. 231 (Nouvelle-Hollande).

An adult male, from Pulo Babi, where "a pair frequented a sand beach at the east point of the island." It was noted on Tuangku, and at Simalur "three were seen on the seashore at Sigoeli." Length, 553 mm.; weight, 1.134 kg. "Iris yellow."

Family RALLIDÆ.

HYPOTÆNIDIA STRIATA (Linnæus).

[*Rallus*] *striatus* LINNÆUS, Syst. Nat., 12th ed., Pt. 1, 1766, p. 262 (Philippines).

"Common in the sowahs. One caught in a rat trap" (Simalur). This specimen, a female, measures 241 mm. "Iris pale yellow brown."

AMAURORNIS PHŒNICURUS (Forster).

[*Rallus*] *phœnicurus* FORSTER, Zool. Indica, 1781, p. 19, pl. IX (Ceylon).

Three specimens, from Simalur, where it was "common in the paddy fields." These examples, all males, measure 298–318 mm. "Iris brown; bill green, brownish over nostrils; forehead red."

Family ARDEIDÆ.

ARDEA SUMATRANA Raffles.

Ardea sumatrana RAFFLES, Trans. Linn. Soc. Lond., XIII, Pt. 2, 1822, p. 32 (Sumatra).

No specimens were shot, but the species was observed both on Bal and Tuangku. On Simalur it was noted as "common. This specie seems to nest singly, not in heronries. A nest, with two well-grow young ones, was found in a tree overhanging the fresh-water cree at Telok Dalam."

DEMIGRETTA SACRA (Gmelin).

[*Ardea*] *sacra* GMELIN, Syst. Nat., I, Pt. 2, 1788, p. 640 (Tahiti).

One female, from Simalur, where it was "common along the se shore." Also noted as "common" on Tuangku.

BUTORIDES JAVANICA (Horsfield).

Ardea javanica HORSFIELD, Trans. Linn. Soc. Lond., XIII, Pt. 1, May, 1821, p. 190 (Java).

"Common" on Simalur, where two males were obtained. Thes measure: Length, 470, 476; wing, 192, 180; culmen, 66 and 64 mm respectively.

ARDEOLA, species.

"*Ardea grayi* (or *bacchus*). One seen in Telok Dalam."

Family TRERONIDÆ.

SPHENOCERCUS OXYURUS (Temminck).

Columba oxyura "REINW." TEMMINCK, Pl. Col., IV (Pt. 41), Dec. 1823, pl. CCI (Java).

One specimen, from Tapanuli Bay. This is sexed as a female, bu agrees with Salvadori's description of the young male.[a] Length, 32

[a] Catal. Birds Brit. Mus., XXI, p. 8.

wing, 158; tail, 127 mm. "Iris, inner circle blue, outer circle pink; feet bright red; bill leaden, base green, cere blue; naked orbital space pale dusty green; claws pale horny brown."

BUTRERON CAPELLEI (Temminck).

Columba capellei TEMMINCK, Pl. Col., IV (Pt. 24), July, 1822, pl. CXLIII (Java).

Four adult males, from Tapanuli Bay. The wing and tail measurements of these individuals agree with those given by Salvadori in his account of this species in the British Museum Catalogue, but the length, in the flesh, is much greater (387–400 mm., instead of 330 mm.). "Iris dull red; eyelids, orbital skin, and feet yellow."

TRERON NIPALENSIS (Hodgson).

Toria nipalensis HODGSON, Asiat. Researches, XIX, Pt. 1, 1836, p. 164, pl. IX, fig. (Nepal).

Three adults, from Tapanuli Bay. The length of the wing varies from 129–137 mm. in two females, while that of the male is 129. "Iris pale orange, with an inner blue circle; naked orbital skin greenish blue; feet deep purple red; bill horny yellow, base deep red."

TRERON FULVICOLLIS (Wagler).

C[*olumba*] *fulvicollis* WAGLER, Systema Avium, I, 1827 [p. 229], ("Java").

One pair from Tapanuli Bay. The male is 281 and the female 273 mm. in length. "Bill leaden, base dark red; feet deep red."

TRERON VERNANS (Linnæus).

Columba vernans LINNÆUS, Mantissa Plant., 1771, p. 526 (Philippines).

Three specimens, from Simalur, where it was "common, and the only small fruit pigeon seen." Length of a male, 298; of a female, 280 mm. The wing measurements are: Male, 153–156; female, 152 mm.

A species of *Treron* was common on Tuangku, but no specimens were preserved.

CARPOPHAGA CONSOBRINA Salvadori.

Carpophaga consobrina SALVADORI, Ann. Mus. Civ. Genova, 2d ser., IV, 1887, p. 558 (Nias Island).

A fine series of 18 skins, from the islands of Simalur, Babi, Lasia, and Tuangku, on each of which it was found to be "common, and not at all shy."

These birds agree with the original description of *C. consobrina*, and in the absence of Nias examples for comparison, I am content to refer them to this species.

As is the case with a number of other species common to several of the islands, the birds living on the insignificant islets Babi and Lasia prove to be larger than their neighbors. In the present species the length of males from Simalur and Tuangku varies from 400 to 432 mm.

(wings, 218–232), while those from Babi and Lasia measure 432 t 440 mm. (wings, 241–245); females from the first-named localities ar from 381 to 407 mm. (wings, 211–231); those from Babi and Lasia ar 419 mm. (wings 232–234). "Iris deep red, eyelids red; bill leaden dark beneath at base; cere dull purple; feet purplish red."

MYRISTICIVORA BICOLOR (Scopoli).

Columba (*bicolor*) SCOPOLI, Del. Flor. Faun. Insub., II, 1786, p. 94 ("nov Guiana").

Reported as "common" on Tuangku, less so on Simalur; noted als on Babi and Lasia.

Two examples (Simalur and Babi).

Family COLUMBIDÆ.

COLUMBA PHASMA, new name.

This is *Columba grisea* (Bonaparte, ex Gray), which is preoccupie by *Columba grisea* Bonaterre, 1790.

Three adult males of this rare species, from Simalur, are apparentl not different from an individual collected by Dr. Abbott on Pulo Tay (southeast of Singkep and Lingga). Length, in the flesh, varies fro 403 to 419 mm.; wings, from 231 to 245 mm.

"Only seen at two places; one was up a fresh-water creek at Telo Dalam, where it was common, and at Labuan Badjau Bay. I only sh four or five in all, and they were in very poor plumage. Only thr skinned. It was shy and hard to get." The colors of the soft par are noted as "iris orange red; bill greenish horny, base, cere, a naked skin about eye dull purple; feet leaden, distal parts of to pinkish white, claws white; anterior parts of tarsi, purple." another specimen the iris was "bright red."

MACROPYGIA SIMALURENSIS Richmond.

Macropygia simalurensis RICHMOND, Proc. Biol. Soc. Wash., XV, August 6, 19 p. 187 (Simalur Island).

Three specimens, from Simalur, where it was "common."

M. ruficeps (Temminck) appears to be its nearest relative, but have no specimens of this form for comparison. The Simalur bi differs from Salvadori's description of *M. ruficeps*[a] in not having t "pectoral feathers more or less broadly tipped with whitish buf and in lacking a whitish throat; the colors of the soft parts are al different.

"Iris bluish gray; feet dark purple brown; bill dark brown, bla at tip."

[a] Catal. Birds Brit. Mus., XXI, p. 361.

CHALCOPHAPS INDICA (Linnæus).

[*Columba*] *indica* LINNÆUS, Syst. Nat., 10th ed., Pt. 2, 1758, p. 164 (India orientali).

"Occasionally seen in the jungle" on Simalur, and "quite common on Pulo Siumat." It was also "heard in the forest" on Babi. No specimens were preserved.

CALŒNAS NICOBARICA (Linnæus).

[*Columba*] *nicobarica* LINNÆUS, Syst. Nat., 10th ed., Pt. 1, 1758, p. 164 (Nicobars).

"A few seen at Telok Dalam," on Simalur, and noticed on Pulo Babi. No specimens.

Family FALCONIDÆ.

ASTUR SOLOËNSIS (Horsfield).

Falco soloënsis HORSFIELD, Trans. Linn. Soc. Lond., XIII, Pt. 1, May, 1821, p. 137 (Java).

"A single male, shot in Labuan Badjau Bay," Simalur. Length, 280 mm. "Iris dark brown, eyelids green; bill black, leaden at base, cere orange; feet yellow, claws black."

ACCIPITER VIRGATUS (Temminck).

Falco virgatus "REINW." TEMMINCK, Pl. Col., I (Pt. 19), February, 1822, pl. CIX (Java).

Four immature females, three from Simalur and one from Lasia. The stomach of one individual and the crop of another contained the remains of small birds.

"A number were seen, both in the forest and about the clearings. Also seen on Pulo Siumat."

SPIZAËTUS ALBONIGER (Blyth).

Nisaëtus alboniger BLYTH, Journ. Asiat. Soc. Beng., XIV, Pt. 1, 1845, p. 173 (Malacca).

"A single male, shot on Pulo Asu, in dense jungle." Length, 514; wing, 311; tail, 208 mm. "Bill and cere black; lores dull leaden; toes yellow, claws black."

A *Spizaëtus*, probably of this species, was seen on Bulo Bangkaru.

HALIÆETUS LEUCOGASTER (Gmelin).

[*Falco*] *leucogaster* GMELIN, Syst. Nat., I, Pt. 1, 1788, p. 257 (no locality given).

On Simalur it was "generally common along the sea shore. One pair was nesting on Pulo Asu and two or three on Pulo Siumat. One nest on the latter island was completed about Christmas day.

There were probably eggs, but the natives were afraid to climb and get them, the tree being large and rotten." It was common on Tuangku, and individuals were observed on Babi, Lasia, Bangkaru, and Mansalar.

Two fine adult males were collected. Length, 660 mm.; weight, 2.154 kg. "Iris brown, mottled with dark spots."

Genus ICTHYOPHAGA Lesson.

Icthyophaga Lesson, L'Écho du Monde Savant, 2e sér, VII, No. 1, January 5, 1843, col. 14.

Type, *Icthyophaga javana* Lesson (=*Falco ichthyætus* Horsfield).

ICTHYOPHAGA ICHTHYÆTUS (Horsfield).

Falco ichthyætus Horsfield, Trans. Linn. Soc. Lond., XIII, Pt. 1, May, 1821, p. 136 (north coast of Java).

An adult female, from Tapanuli Bay. Length, 660 mm.; weight, 2.494 kg. "Iris straw yellow."

Icthyophaga, of Lesson, has priority over the other generic names employed for this eagle.

SPILORNIS BACHA (Daudin).

Falco bacha Daudin, Traité d'Orn., II, April, 1800, p. 43 (from Levaillant, Ois. d'Afr., I, p. 69, pl. xv).

An immature female, from Tapanuli Bay, appears to belong to this species. Length, 612; wing, 369; tail, 253 mm. "Iris grayish olive; feet pale yellow; bill leaden, black at tip; lores pale yellow."

SPILORNIS ABBOTTI, new species.

Type.—Adult male, No. 179094, U.S.N.M.; Simalur Island, west coast of Sumatra, December 1, 1901; Dr. W. L. Abbott. Cap black the feathers white at base; longest nuchal feathers pale cinnamon at tips; mantle, scapulars, back, rump, tertiaries, greater and middle wing coverts, dark brown, with a purplish gloss, most of the feathers tipped with pale cinnamon; lesser wing-coverts black, sparsely dotted with small white spots; primaries, and primary coverts, glossy black, some of the latter narrowly spotted with white at the tips; secondaries like the tertiaries, becoming black terminally, most of them narrowly tipped with white; upper tail-coverts like the back, rusty at the tips some of the feathers with small lateral white spots at the tips; tail black, most of the feathers narrowly tipped with whitish; near the outer third of the tail there is a band of grayish white, about 20 mm wide, extending across all of the feathers; this band obscurely mottled with brownish gray above, but paler and of a more uniform shade on the under surface; near the base of the tail, and concealed by the

coverts, there are indications of a second pale bar. Ear coverts and malar region dark brown (between sepia and clove brown); sides of neck similar, each feather tipped with pale cinnamon; chin, throat, and chest brown (paler than the ear-coverts), barred and tipped with Mars brown, the bars darker and broader on the latter; breast and sides Mars brown, narrowly barred with blackish brown, with occasional lateral white spots; abdomen, flanks, and under tail coverts Mars brown, with more numerous lateral white spots, which are surrounded by dark brown; under wing-coverts and axillaries like the abdomen, the edge of the wing being more prominently mottled with white; under surface of wing dusky, with a broad obscure pale bar on the inner webs of the feathers about 95 mm. from their tips; near the base of each feather there are one or two white spots of irregular shape and size.

Length, 527; wing, 347; tail, 228; tarsus, 82; bill, from gape, 38 mm.

"Iris yellow; cere and naked face deep yellow; bill horn blue, black at tip; feet yellow, claws black."

There is some variation in color shown in this series, especially in the markings of the tail, under surface of the wings, and of the throat and chest, but the general appearance of each bird is very like that of the type.

In some younger individuals many feathers of the scapulars, tertiaries, and greater wing-coverts are narrowly tipped with white, or have small lateral white spots at the tips, while the black crown feathers have pale rusty edges.

The dimensions of this species are: Males, length, 502–546; wing, 328–360; tail, 217–233; tarsus, 77–83 mm.; females, length, 495–559; wing, 315–358; tail, 210–235; tarsus, 75–87 mm.

This species seems to have its nearest relative in *S. davisoni* Hume,[a] but differs in being smaller, and in having the bend of the wing mottled, instead of uniform white or yellowish white; in *S. davisoni* the tibial plumes are barred, but in the new species they are spotted.

The dimensions of *S. davisoni*, as given by Hume, are: Length, 559–609; wing, 356–394; tail, from vent, 254–280; tarsus, 79–97 mm.[b]

Dr. Abbott found the new species "common in the jungle, and especially on the edges of clearings. Not at all shy, and easily called up." Snakes, centipedes, lizards, and remains of crabs were found in the stomachs of the specimens collected.

All of the specimens, 15 in number, were obtained on Simalur.

A bird of this genus may occur on Tuangku, where "the peculiar cry of *Spilornis* was never heard, but a large hawk was seen once or twice in the forest which may have been *Spilornis*."

[a] Stray Feathers, I, p. 306; II, p. 147.

[b] Measurements originally in inches.

HALIASTUR INDUS INTERMEDIUS (Blyth).

[*Haliastur*] *intermedius* BLYTH (Gurney MS.), Ibis, 1865, p. 28 (Java).

"Common at Sigoeli, and several seen at other places" on Simalur; also noted on Tuangku and on Mansalar. Two specimens, one of them from Tapanuli Bay.

MICROHIERAX FRINGILLARIUS (Drapiez).

Falco fringillarius DRAPIEZ, Dict. Class. d'Hist. Nat., VI, 1824, p. 412 ("des Indes").

Four adults, from Loh Sidoh Bay. One specimen a male, has indications of a white collar on the nape.

? FALCO PEREGRINUS Tunstall.

[*Falco*] *peregrinus* TUNSTALL, Orn. Britannica, 1771, p. 1 (Great Britain).

"A falcon was seen in Telok Dalam and fired at twice, when it dropped a *Calornis* which it had in its claws. The dark cheek stripe was plainly visible."

Family BUBONIDÆ.

PISORHINA UMBRA, new species.

Type.—Adult male, No. 179101, U.S.N.M.; Simalur Island, west coast of Sumatra, November 29, 1901; Dr. W. L. Abbott. General color of the upper parts, brown (between Mars brown and russet), paler on the wings, all of the feathers finely dotted with dusky, those of the crown being prominently marked with irregular black streaks and bars; feathers of the crown, ear tufts, and mantle with more or less concealed russet bars or bases, mingled with blackish bars or markings; outer scapulars with conspicuous white spots, tipped with black and russet; wing-coverts mainly like the mantle, the greater coverts somewhat paler; primary coverts and alula more prominently marked with dusky, the feathers of the latter with three or four pale bars on the outer webs. Primaries narrowly bordered with dusky, the outer webs with several deep buff or cinnamon bars; rump, upper tail-coverts, and tip of tail like the mantle, basal two-thirds of the tail darker, with several pale cinnamon bars, each one with dusky borders. Sides of neck and chest like the mantle, but with distinct narrow blackish bars or vermiculations, some of the feathers of the chest with blackish shaft spots; throat paler, with irregular blackish markings; base of malar region with more prominent black spots, mingled with white and russet, forming a well defined patch; ear-coverts and sides of face russet, with obscure dusky markings; chin white; forehead and feathers above eyes, white, mottled with russet and black. Breast, sides, flanks, and abdomen like the chest, but the feathers barred and freckled with white, especially on the latter; thighs and tarsus russet

freckled with dusky; under tail-coverts white, barred and mottled with russet and dark brown at the tips; under wing-coverts and axillaries pale russet or buff, with blackish markings; under primary coverts buff, with broad dusky tips; under surface of wings dusky, paler and obscurely dotted at tip; inner feathers buff, basally, barred with buff for about two-thirds of their length (outer primary barred at base only).

Length, 191; wing, 143; tail, 61; tarsus, 23; bill, from gape, 19 mm.

"Iris greenish yellow; bill pale brown, black at tip; feet pale fleshy brown. Stomach contained insects. Shot in bright sunlight while sitting on a bush by a fresh-water creek at Telok Dalam."

This species appears to be nearest to *P. alfredi* Hartert, from Flores, but is smaller, has the tail plainly barred, and differs from it in various details.

SYRNIUM NIASENSE Salvadori.

Syrnium niasense SALVADORI, Ann. Mus. Civ. Genova, 2d ser., IV, 1887, p. 526 (Nias Island).

One pair, from Pulo Bangkaru. The dimensions are: Male, length, 381; wing, 297; tail, 156; female, length, 406; wing, 303; tail, 170 mm. "Toes and bill leaden; cere dark leaden."

These birds appear to be *S. niasense*, but the measurements are somewhat greater than those given by Salvadori.

Family PSITTACIDÆ.

PALÆORNIS MAJOR Richmond.

Palæornis major RICHMOND, Proc. Biol. Soc. Wash., XV, August 6, 1902, p. 188 (Pulo Babi, west coast of Sumatra).

Six specimens from Babi and one from Lasia. The latter, a male, is even larger than the type, measuring: Length, 445; wing, 194; tail, 229 mm. Another male, from Babi, has a wing 196 mm. long. The females are a little smaller (wing about 186 mm). The color is exactly that of *P. fasciatus*.

"Upper mandible red, tip yellow; lower mandible black; iris pale yellow, with an inner circle dull green; cere greenish leaden; feet pale green." In the female the whole bill is black. "Much larger than the *Palæornis* of Simalur, about 16½ inches long. Common. In pairs, evidently breeding. Owing to the dense jungle difficult to see and shoot."

PALÆORNIS FASCIATUS (Müller).

Psittacus fasciatus P. L. S. MÜLLER, Natursyst., Suppl., 1776, p. 74 (Pondichery).

"Generally common" on Simalur. Nine specimens were obtained, agreeing in size with Andaman birds. Males measure: Length, 368–394; wing, 171–176; females, length, 351–368; wing, 165–175 mm.

PSITTINUS ABBOTTI Richmond.

Psittinus abbotti Richmond, Proc. Biol. Soc. Wash., XV, August 6, 1902, p. 188 (Simalur Island, west coast of Sumatra).

Eight specimens, all from Simalur.

This species is conspicuously unlike the only previously known member of the genus, *P. incertus*, differing in having the mantle, rump, upper tail-coverts and lower surface green, a brighter blue head, a greenish patch on the crown, and a black band across the nape. It is also considerably larger than the common species.

The female is duller in color, has no blue on the head (which is like the mantle), and no black band on the nape. The upper mandible is brown instead of red. The cere is dull green in both sexes, but in two males is marked as "dark brown." In males the length of the wing ranges from 139 to 144 mm.; in females from 134 to 141.

"Pretty common, but I only obtained them at Sibaboh, where a flock used to frequent two or three trees that were bearing a small wild fruit. The parrots were very tame, and would allow me within a few feet. I often used to see them flying over the forest, and saw a few on Pulo Siumat, but never obtained them again."

LORICULUS GALGULUS (Linnæus).

[*Psittacus*] *galgulus* Linnæus, Syst. Nat., 10th ed., I, 1758, p. 103 ("India").

One example, from Pulo Tuangku, where "common."

This specimen was sexed as a male, but appears to be in the plumage of the female, a specimen of which is not available for comparison. In the Tuangku bird there are traces of a golden band on the lower back, separating the green from the scarlet, and the longer upper tail-coverts extend to the tip of the tail.

"Cere dark brown; upper mandible dark brown, lower one paler brown; tarsi greenish; toes pale fleshy brown." Length, 133 mm.

Family CUCULIDÆ.

CACOMANTIS SEPULCRALIS (S. Müller).

C[*uculus*] *sepulcralis* S. Müller, Verh. Nat. Gesch. (Land-en Volkenkunde), 1843, p. 177, note (Java; Sumatra).

Two immature birds, male and female, from Simalur. The former has the "iris gray brown; eyelids greenish yellow; feet yellow, claws black; bill black, brownish yellow beneath at base; inside of mouth orange;" in the latter the iris is "reddish brown, becoming gray externally." Length of the male, 235; wing, 115; of the female, 232; wing 113 mm. "One shot in dense forest and one sitting on a dead tree in a clearing."

EUDYNAMYS HONORATA MALAYANA (Cabanis and Heine).

E[udynamis] malayana CABANIS and HEINE, Mus. Hein., IV, Pt. 1, 1862, p. 52 (Sunda Islands; Sumatra).

"Common" on Simalur and Babi; also noted on Lasia.

One specimen each, from Simalur, Babi, and Loh Sidoh Bay. The first (female) measures, length, 397; wing, 187; the second (male), length, 438; wing, 205; bill, from gape, 43; the third (male), length, 419; wing, 195 mm.

RHOPODYTES DIARDI (Lesson).

Melias diardi LESSON, Traité d'Orn. (Pt. 2), May, 1831, p. 132 (Java).

An adult female, from Tapanuli Bay. Length, 368 mm. "Iris dark brown?, sclera blue; naked skin about eye deep crimson; feet dark leaden; bill green, with a pale blue spot above nostril."

PHŒNICOPHAUS ERYTHROGNATHUS Bonaparte.

[Phaenicophaeus] erythrognathus "TEMM." BONAPARTE, Consp. Gen. Avium, I, 1849, p. 98 (Sumatra).

One adult male, from Loh Sidoh Bay. Length, 457 mm.

The differences in plumage between males and females of the allied *P. microrhinus*, pointed out by Berlepsch[a] and confirmed by Büttikofer,[b] are equally evident in this species. Another sexual character, apparently not before mentioned, is the color of the iris, which is blue in the male and orange yellow or yellow in the female. Büttikofer found the color of the iris in *P. microrhinus* to be very variable, but considered it to be independent of age or sex.[c]

Family CORACIIDÆ.

EURYSTOMUS CALONYX Sharpe.

Eurystomus calonyx "(HODGS.)" SHARPE, Proc. Zool. Soc. Lond., Pt. 3, 1890, p. 551 (Nepal[d]).

"A few seen" on Simalur, where an adult male was obtained December 15.

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[a] Nov. Zool., II, p. 73.

[b] Notes Leyden Mus., XXI, p. 172.

[c] Idem, p. 171.

[d] This locality is not specifically mentioned in the original description, where only the general distribution of the species is given ("extends throughout the Himalayan Terai from Kumaon to Darjiling and upper Assam, probably breeding throughout the whole of this range"). Later, we learn (Catal. Birds Brit. Mus., XVII, 1892, p. 38) that the type is from Nepal. It is a common practice with many European authors to give the entire distribution of a new species, at the same time omitting the all-important type locality.

Family MEROPIDÆ.

MELITTOPHAGUS URICA (Swainson).

Merops urica SWAINSON (from Horsfield, MS.), Zool. Illustr., I, No. 2, November, 1820, pl. VIII (Ceylon).

This is *Melittophagus swinhoii* of authors, but Swainson's name has clear priority and should be used.

Dr. Abbott saw a single individual at Sibaboh Bay, Simalur, which he identified as "*M. swinhoii*," but no specimens were obtained.

MEROPS PHILIPPINUS Linnæus.

[*Merops*] *philippinus* LINNÆUS, Syst. Nat., 12th ed., Pt. 1, 1766, p. 183 [errata] (Philippines).

Specimens are in the collection from Simalur and Tapanuli Bay. It is reported as "common about the clearings" at the first-named locality and also on Tuangku.

FAMILY ALCEDINIDÆ.

PELARGOPSIS JAVANA FRASERI (Sharpe).

Pelargopsis fraseri SHARPE, Proc. Zool. Soc. Lond., 1870, p. 65 (Java; Malacca; Penang).

An adult female from Pulo Mansalar measures, length, 368; wing, 147; three adults from Tapanuli Bay give the following measurements: Female, length 381, wing 160; male, length 368, wing 144; male, length 356, wing 146 mm. These examples have slightly darker caps and somewhat deeper blue upper parts than specimens from Singapore, Lingga, and eastern Sumatra.

PELARGOPSIS SIMALURENSIS, new species.

Type.—Adult male, No. 179205, U.S.N.M.; Simalur Island, west coast of Sumatra, November 29, 1901; Dr. W. L. Abbott. Crown, nape, lores, ear-coverts, and infraorbital region Isabella color, with a buff line above the lores, eyes, and ear-coverts, and a wash of buff under the eyes; mantle and wing-coverts dark brownish green (near bottle green), each feather edged with greenish blue (near verditer blue); wings dusky black at the tips, sea green externally, except on apical part of outer primaries (first primary without any green and second with basal part only green); tail sea green, the inner webs of all but the middle pair of feathers dull black; shaft, and a narrow line bordering the shaft of each feather, dull black. Back, rump, and median upper tail-coverts pale turquoise or silvery blue; lateral upper tail-coverts and longest median ones, like the mantle; under parts, including under wing-coverts, axillaries, sides of neck, a narrow line across nape, and malar region, ochraceous, paling to deep buff on throat; under surface of wings (basal portion), buff.

Length, 369; wing, 141; tail, 94; tarsus, 17; culmen, 81.5 (bill, from gape, 92); width of lower mandible, at base, 26 mm. "Feet red, claws horn brown; bill red, with black tip."

The green shades of the upper surface are changeable, as in other birds of this genus, becoming deep purplish blue in certain lights. The above description was taken with the bird held in Gadow's position "A."

This form differs from *fraseri* in having a paler cap (the feathers without darker centers), darker mantle, and less of a bluish shade on the upper parts, especially on the wings and tail. The bill appears to be slightly longer and broader than in *fraseri;* but birds of the same sex should be compared, as females are usually larger than males. A female of *P. simalurensis* has the following dimensions: Length, 381; wing, 152; tail, 97; tarsus, 17; culmen, 83 (bill, from gape, 95) mm.

Five specimens, from Simalur, where it was "common along the sea coast and creeks."

PELARGOPSIS SODALIS, new species.

Type.—Adult female, No. 179208, U.S.N.M.; Pulo Tuangku, Banjak Islands, west coast of Sumatra, January 25, 1902; Dr. W. L. Abbott. Color as in *P. simalurensis*, but cap rather lighter and grayer; size larger.

Length, 407; wing, 160; tail, 101; tarsus, 19.5; culmen, 88 (bill, from gape, 100); width of lower mandible, at base, 29 mm. "Bill red, brownish above at tip; feet red, claws dark brown."

A second female measures: Length, 394; wing, 158; tail, 103; culmen, 87 (bill, from gape, 99); width of lower mandible, at base, 27 mm. "Remarkably large sized. A female was 16 in. long."

ALCEDO ISPIDA BENGALENSIS (Gmelin).

[*Alcedo*] *bengalensis* Gmelin, Syst. Nat., I, Pt. 1, 1788, p. 450 (Bengal).

Four specimens, collected on Simalur and at Tapanuli Bay. It was seen, but not obtained, on Tuangku.

ALCEDO MENINTING Horsfield.

Alcedo meninting Horsfield, Trans. Linn. Soc. Lond., XIII, Pt. 1, May, 1821, p. 172 (Java).

Several specimens. "A small bright-colored kingfisher, either this or *beavani* was seen on a fresh-water creek in dense forest at Telok Dalam. Probably the same as that afterwards obtained in Pulo Tuangku and at Tapanuli Bay."

CEYX, species.

"Frequently heard in the forest and once or twice seen" on Simalur. A *Ceyx* was also seen on Bangkaru.

HALCYON COROMANDA (Latham).

[*Alcedo*] *coromanda* LATHAM, Index Ornith., I, 1790, p. 252 ("Coromandela").

Two from Tapanuli Bay. It was also noted on Simalur and Lasia.

HALCYON PILEATA (Boddaert).

Alcedo pileata BODDAERT, Tabl. Pl. Enl., 1783, p. 41 (China).

Four from Simalur and one from Tapanuli Bay, all males. The stomach of one specimen contained a lizard. Total length varies from 292 to 299 mm.

On Simalur it was "found along fresh-water creeks and streams: not so common as the last" [*A. chloris*]. Seen also on Babi.

? HALCYON CHLORIS (Boddaert).

Alcedo chloris BODDAERT, Tabl. Pl. Enl., 1783, p. 49 (Buffon, Hist. Nat. Ois., VII, p. 190; Bouro, Moluccas).

Three adult males, from Simalur. In these specimens the color seems to be that of *H. armstrongi*, with perhaps a little less green on the ear-coverts. They are very much like Natuna birds. Size large; wings, 115–117; bill, from gape, 58–60 mm.

"Generally common."

? HALCYON ARMSTRONGI Sharpe.

Halcyon armstrongi SHARPE, Catal. Birds Brit. Mus., XVII, 1892, p. 277 ("from the Sunderbunds to Burmah, Tenasserim, and Siam, south to the Malayan Peninsula, Sumatra, and Northern Borneo").

An adult male, from Loh Sidoh Bay. This individual has greener ear coverts than those recorded above as *H. chloris*. Loh Sidoh Bay is practically the same as Acheen, whence Sharpe has recorded *H. chloris*.

Family BUCEROTIDÆ.

DICHOCEROS BICORNIS (Linnæus).

[*Buceros*] *bicornis* LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 104 ("China").

One specimen, from Tapanuli Bay. Length, 109.2 cm.; weight, 2.381 kg.

ANTHRACOCEROS CONVEXUS (Temminck).

Buceros convexus TEMMINCK, Pl. Col., II (Pt. 89), Feb., 1832, pl. DXXX (Java).

"Common" on Pulo Mansalar. Length, 787 mm.

RHYTIDOCEROS UNDULATUS (Shaw).

Buceros undulatus SHAW, General Zool., VIII, Pt. 1, 1811, p. 26 (Java).

"Common" on Pulo Mansalar, but no specimens were obtained.

ANORRHINUS GALERITUS (Temminck).

Buceros galeritus TEMMINCK, Pl. Col., II (Pt. 88), May, 1831, pl. DXX (Sumatra; western part of Borneo).

Three males, from Tapanuli Bay. Length, 800–813 mm.

"Iris dull red; gular space and naked orbital ring white, dull blue n front of eye."

Family CAPITONIDÆ.

CHOTORHEA CHRYSOPOGON (Temminck).

Bucco chrysopogon TEMMINCK, Pl. Col., III (Pt. 48), July, 1824, pl. CCLXXXV (Sumatra).

An adult male, from Tapanuli Bay. Length, 305 mm.

CHOTORHEA MYSTACOPHANES (Temminck).

Bucco mystacophanes TEMMINCK, Pl. Col., III (Pt. 53), Dec., 1824, pl. CCCXV (Sumatra).

Three adults from Tapanuli Bay, where "common in heavy forest, sitting on high trees." Length, 232–235 mm.

"Iris dark brown; bill black, leaden at base, beneath; feet greenish."

CYANOPS HENRICII (Temminck).

Bucco henricii TEMMINCK, Pl. Col., III (Pt. 88), May, 1831, pl. DXXIV (Sumatra).

Tapanuli Bay; one adult female. Length, 226; culmen, 27.5; width of bill, at base, 20 mm.

MEZOBUCCO DUVAUCELII (Lesson).

Bucco duvaucelii LESSON, Traité d'Orn. (Pt. 3), July, 1830, p. 164 (Sumatra).

Three adults, from Tapanuli Bay.

Family PICIDÆ.

CALLOLOPHUS MALACCENSIS (Latham).

[*Picus*] *malaccensis* LATHAM, Index Ornith., I, 1790, p. 241 (Malacca).

An adult male, from Loh Sidoh Bay.

BLYTHIPICUS PORPHYROMELAS (Boie).

Picus porphyromelas BOIE, "Briefe geschr. aus Ostind., p. 143 (1832)."

An adult male, from Tapanuli Bay. Length, 229 mm.

"Iris deep red; feet dark leaden."

MEIGLYPTES TUKKI (Lesson).

Picus tukki LESSON, Revue Zool., II, June, 1839, p. 167 (Sumatra).

Three specimens; a pair from Tapanuli Bay, and an adult female from Pulo Tuangku. In color the Tuangku bird is identical with *tukki*, but it is larger than any other specimen in our series of this species. Length, 225; wing, 110; bill, from gape, 30 mm.

MICROPTERNUS PHAIOCEPS BRACHYURUS (Vieillot).

Picus brachyurus VIEILLOT, Nouv. Dict. d'Hist. Nat., XXVI, 1818, p. 103 (Java).

An adult female, from Tapanuli Bay.

TIGA JAVANENSIS (Ljungh).

Picus javanensis LJUNGH, K. Vet. Akad. Nya Handl., XVIII, 1797, p. 137, pl. VI (Batavia, Java).

One specimen, an adult male, from Loh Sidoh Bay.

THRIPONAX JAVENSIS (Horsfield).

Picus javensis HORSFIELD, Trans. Linn. Soc. Lond., XIII, Pt. 1, May, 1821, p. 175 (Java).

A female, from Pulo Mansalar, shot March 13, "contained well-developed eggs." This individual has distinct white tips to some of the primaries, as is often the case in this species.

THRIPONAX PARVUS Richmond.

Thriponax parvus RICHMOND, Proc. Biol. Soc. Wash., XV, August 6, 1902, p. 189 (Simalur Island, west coast of Sumatra).

Twelve specimens, from Simalur. This species is indistinguishable from *T. javensis*, except by its smaller size. Not one of the specimens, however, shows any white on the tips of the primaries. The wing measurement in the male varies from 166 to 179; in the female, from 169 to 176 mm. Length, in the male, from 359 to 381 mm. "Common. The only woodpecker seen. A miniature of *T. javensis*. Iris straw yellow; bill black; feet dull leaden."

Family TROGONIDÆ.

PYROTROGON DUVAUCELII (Temminck).

Trogon duvaucelii TEMMINCK, Pl. Col., III (Pt. 49), August, 1824, pl. CCXCI (Sumatra).

One adult male, from Tapanuli Bay.

Family MACROPTERYGIDÆ.

MACROPTERYX PERLONGA, new species.

Type.—Adult female, No. 179169, U.S.N.M.; Simalur Island, west coast of Sumatra, January 2, 1902; Dr. W. L. Abbott. Color that of the female of *M. longipennis*, but size larger.

Length, 232; wing, 184; tail, 113.5 mm. In *M. longipennis* the wing is about 165, and the tail 102 mm., or less.

M. perlonga doubtless occurs on other islands off the west coast of Sumatra, as it has been recorded from Engano by Salvadori,[a] with a wing measurement of 185 mm.

"Common, but flies very high, and when settling does so upon very high trees, so that though I fired a number of times I only got one, a female. This seems much larger than *longipennis*."

MACROPTERYX COMATA (Temminck).

Cypselus comatus Temminck, Pl. Col., IV (Pt. 45), April, 1824, pl. cclxviii (Sumatra).

An adult female, from Tapanuli Bay.

Family MICROPODIDÆ.

? SALANGANA FRANCICA (Gmelin).

"Many seen. The nests are gathered in considerable quantities." On Tuangku. Identified as above by Dr. Abbott. Possibly *S. inexpectata* (Hume).

SALANGANA FUCIPHAGA (Thunberg).

Hirundo fuciphaga Thunberg, K. Vet. Akad. Nya Handl., XXXIII, 1812, p. 153, pl. iv (Java).[b]

One pair, from Simalur, where it was "common."

Family EURYLAIMIDÆ.

EURYLAIMUS OCHROMALUS Raffles.

Eurylaimus ochromalus Raffles, Trans. Linn. Soc. Lond., XIII, Pt. 2, 1822, p. 297 (Singapore; interior of Sumatra).

Three females, from Pulo Tuangku.

"Common. A partly finished nest obtained January 29, hung from the extremity of a branch of a lime tree in a clearing; 30 feet from the ground."

CYMBIRHYNCHUS LEMNISCATUS (Raffles).

Eurylaimus lemniscatus Raffles, Trans. Linn. Soc. Lond., XIII, Pt. 2, 1822, p. 296 (interior of Sumatra).

An adult male, from Tapanuli Bay. Length, 235 mm.

The white spots are almost obsolete on the tail of this specimen, occurring on the two outermost feathers only. The crissum and longer upper tail-coverts are orange-rufous, instead of crimson.

"Iris, emerald green; feet leaden blue, soles pale fleshy."

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[a] Ann. Mus. Civ. Genova, 2d ser., XII, 1892, pp. 128, 129.

[b] Authors generally, since the time of Horsfield and Moore's catalogue, have given "1772" as the date of publication of this name. Giebel gives the correct date in his Thesaurus.

Family PITTIDÆ.

PITTA MOLUCCENSIS (P. L. S. Müller).

Turdus moluccensis Müller, Natursyst., Suppl., 1776, p. 144 ("moluccischen Inseln").

A single adult female from Pulo Tuangku. Length, 200; wing, 116; tarsus, 40; bill, from gape, 29 mm. Compared with a series of fresh specimens from the Malay Peninsula, this bird is rather small, with more yellowish in the green of the upper parts; the white patch on the primaries is much restricted, the black tips of the feathers occupying more space than in any of our other specimens.

"Common. Feet pale purplish fleshy."

Family MOTACILLIDÆ.

Genus DENDRONANTHUS Blyth.

Dendronanthus Blyth, Ann. and Mag. Nat. Hist., 1844, p. 116.

Type, *Motacilla indica* Gmelin.

DENDRONANTHUS INDICUS (Gmelin).

[*Motacilla*] *indica* Gmelin, Syst. Nat., I, Pt. 2, 1788, p. 962 (Sonnerat's "La bergeronnette grise des Indes").

Two specimens, one from Simalur, the other from Loh Sidoh Bay. It was "common" at the first-named locality, and was noted also on Pulo Bangkaru.

This bird has received several generic names, the earliest of which appears to be *Dendronanthus* Blyth (1844). The next is *Nemoricola* "Blyth,"[a] which may clash with *Nemoricola* of Hodgson, for a species of snipe.[b] *Limonidromus*, of Gould, commonly used for the species, dates from 1862, and Fitzinger's *Nemoricaga* was proposed about the same time. *Budytanthus*, of David,[c] is still later.

MOTACILLA MELANOPE Pallas.

Motacilla melanope Pallas, Reise Russischen Reichs, III, 1776, p. 696 ("In Dauuria circa ripas glareosas rarius occurrit").

An adult male, from Simalur, where "common."

BUDYTES FLAVUS LEUCOSTRIATUS (Homeyer).

Budytes leucostriatus Homeyer, Journ. für Orn., 1878, p. 128 (Baical region).

One specimen, an adult male, from Simalur. "Common."

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[a] Jerdon, Madras Journ., XIII, p. 132, dated 1844, but not published befor August, 1845.

[b] Journ. Asiat. Soc. Bengal, VI, 1837, p. 491. Hodgson writes: "I have set it dow in my notebook as the type of a new genus or subgenus, under the style of *Nemoricola Nipalensis*, but I forbear, for the present, from so naming it." Gray used thi name in 1842 (Appendix to List Genera Birds, 1842, p. 14).

[c] Nouv. Arch. du Mus., III (Bull.), 1867, p. 33.

Family PYCNONOTIDÆ.

CHLOROPSIS CYANOPOGON (Temminck).

Phyllornis cyanopogon Temminck, Pl. Col., IV (Pt. 81), October, 1829, pl. DXII, fig. 1 (Sumatra).

An adult male, from Tapanuli Bay. Length, 178 mm.

IRENA CRINIGER Sharpe.

Irena criniger Sharpe, Catal. Birds Brit. Mus., III, 1877, p. 267 (Borneo and Sumatra).

Six specimens, from Pulo Mansalar, Tapanuli Bay, and Tuangku. These birds are identical in color with *I. criniger*, but the Tuangku specimens, four in number, differ in having larger and heavier bills, with rather larger wings (bill, from gape, 30; wing, 123–129 mm.).

"Common," on Tuangku.

HEMIXUS MALACCENSIS (Blyth).

H[ypsipetes] malaccensis Blyth, Journ. Asiat. Soc. Beng., XIV, Pt. 2, 1845, p. 574 (Malacca).

Four specimens, all from Tapanuli Bay. Length, 219-229 mm. "These two pairs shot in heavy forest on Gunong Kebong, where they were pretty common. Iris clear brown; feet dark fleshy brown."

IOLE OLIVACEA Blyth.

I[ole] olivacea Blyth, Journ. Asiat. Soc. Beng., XIII, Pt. 1, 1844, p. 386 (supposed to be from Singapore).

An adult male, from Tapanuli Bay. Length, 194 mm. "Iris gray."

EUPTILOSUS EUTILOSUS (Jardine and Selby).

Brachypus eutilosus Jardine and Selby, Illustr. Orn., new ser., No. 1, February, 1837, pl. III (Singapore).

One specimen, from Tapanuli Bay. Length, 206 mm. "Iris red; bill and feet black."

MICROTARSUS MELANOCEPHALOS (Gmelin).

[*Lanius*] *melanocephalos* Gmelin, Syst. Nat., I, Pt. 1, 1788, p. 309 ("in insulis Sandwich maris australis").

Seven adults from Simalur and one from Tapanuli Bay. The Simalur birds do not differ in color from those of Borneo and the Malay Peninsula, but the bills are perceptibly stouter. Length, 172-184; wing, 77–79 mm. "The only bulbul noticed. Common about the clearings in scrubby jungle" (Simalur).

TRICHOLESTES CRINIGER (Blyth).

Br[achypodius]? criniger "A. Hay" Blyth, Journ. Asiat. Soc. Beng., XIV, Pt. 2, 1845, p. 577 (Malacca).

Three specimens are in the collection, from Pulo Mansalar and Tapanuli Bay.

TRACHYCOMUS OCHROCEPHALUS (Gmelin).

[*Turdus*] *ochrocephalus* GMELIN, Syst. Nat., I, Pt. 2, 1788, p. 821 ("Zeylon et Java").

A female, from Loh Sidoh Bay. Length, 267 mm. "Iris brownish red."

PYCNONOTUS ANALIS (Horsfield).

Turdus analis HORSFIELD, Trans. Linn. Soc. Lond., XIII, Pt. 1, May, 1821, p. 147 (Java).

One male, from Loh Sidoh Bay. Length, 203 mm. "Iris dark brown; bill and feet black."

PYCNONOTUS PLUMOSUS Blyth.

P[*ycnonotus*] *plumosus* BLYTH, Journ. Asiat. Soc. Beng., XIV, Pt. 2, 1845, p. 567 (Singapore).

Adults from Tuangku, Mansalar, and Tapanuli Bay. These do not differ from Singapore specimens. "Iris brownish yellow; feet fleshy brown."

PYCNONOTUS SIMPLEX Lesson.

Picnonotus simplex LESSON,[a] Revue Zool., II, June, 1839, p. 167 (Sumatra).

Seven specimens, from Loh Sidoh Bay, Tuangku, and Bangkaru. It was found to be "common" on both of the Banjak islands. Length, from 181 to 191 mm. The irides in six of the skins are noted as "red," but in one male from Tuangku are stated to be "brownish yellow."

PYCNONOTUS, species.

One pair, from Tapanuli Bay. Length of male, 178; of female, 158 mm. "Iris pale yellow; feet fleshy brown."

This species is related to *P. simplex*, but is easily distinguished by its paler color below, paler sides and under tail-coverts, smaller size (or slenderer appearance in the prepared skin), and white or pale yellow irides. We have about thirty skins of this form and an equal number of *P. simplex*, all nicely prepared and properly sexed, with color notes, and no difficulty is experienced in dividing them into two lots, except in the case of birds from Subi and Sirhassen, in the Natunas, which have the plumage of the present bird, with the red irides of *P. simplex*. We have *P. simplex*, with red irides, from Trong, Pulo Lankawi, the Dindings, the Butang Islands, Singapore, Pulo Tioman, the Anambas, Indragiri River (Sumatra), Borneo, Loh Sidoh Bay, and the Banjak Islands. The present species (white or yellowish white irides, except as mentioned above) is represented from Tapanuli Bay, Lingga Island, Singapore, east coast of Johore, Borneo, Trong, and from the Anambas and Natunas.

[a] Lesson's description is as follows: "Corpore suprà griseo-luteolâ, albo lute[o] tincto infrà; rostro corneo; pedibus bruneis. Hab. Sumatra."

Lesson, in his description of *P. simplex*, did not give the color of the irides, but it may be assumed[a] that he had the red-eyed form. The status of the white-eyed bird can be properly determined only by an examination of the types of *P. brunneus* and *P. modestus* Blyth, and of *Microtarsus olivaceus* Moore, any one of which may refer to it.

PYCNONOTUS ERYTHROPTHALMOS (Hume).

I[xos] erythropthalmos HUME, Stray Feathers, VI, 1878, p. 314 (Pakchan, Tenasserim).

One adult male from Pulo Tuangku. Length, 165 mm.

"Iris red; eyelids orange; angles of mouth and inside of mouth orange; feet brownish fleshy."

This is *P. pusillus* Salvadori (not *Hæmatornis pusillus* Blyth), renamed *P. salvadorii* by Sharpe.[b]

Family TIMALIIDÆ.

ANUROPSIS MALACCENSIS (Hartlaub).

Brachypteryx malaccensis HARTLAUB, "Syst. Verz. nat. Samml. Gesellsch. Mus., I, Vögel, 1844," p. — (Malacca).

One pair from Pulo Tuangku. "Common in the forest."

These are similar to Malaccan birds.

MIXORNIS PILEATUS (Blyth).

Prinia pileata BLYTH, Journ. Asiat. Soc. Beng., XI., Pt. 1, 1842, p. 204 (Malay Peninsula).

One adult male from Pulo Bangkaru. This is as dark on the upper surface as *M. everetti*, from the Natunas, but in other respects is similar to Singapore birds.

Mixornis gularis (*Motacilla gularis* Raffles, 1822) as commonly applied to this species is preoccupied (*Motacilla gularis* Shaw, Cimelia Physica, 1796, p. 61).

CYANODERMA FULVIVENTRIS, new species.

Type.—Adult male, No. 179359, U. S. N. M.; Pulo Tuangku, Banjak Islands, west coast of Sumatra, February 1, 1902; Dr. W. L. Abbott.

Similar to *C. erythroptera*, but throat, breast, sides of head, and neck darker slate color; abdomen, sides, flanks, and under tail-coverts deeper fulvous; bill slightly longer and total length a trifle greater.

Length, 146; wing, 59; tail, 50; tarsus, 21; culmen, 17 (bill, from gape, 20) mm. "Iris brownish red; naked skin on throat pale blue; naked skin about eyes dark blue."

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[a] The type was in the collection of Dr. Abeillé, of Bordeaux, and may still be extant.

[b] Catal. Birds, VI, 1881, p. 401.

Two males and two females from Tuangku, all agreeing with the above characters; the females, as in *C. erythroptera*, being a little smaller than the males. "Common."

STACHYRIS BANJAKENSIS Richmond.

Stachyris banjakensis RICHMOND, Proc. Biol. Soc. Wash., XV, August 6, 1902, p. 190 (Pulo Tuangku, Banjak Islands).

Two adult males from Tuangku.

This species has a longer bill than typical *S. maculata;* is more heavily spotted below, and has a paler nape, back, and wings. Both species have a large pale-blue bare space on the side of the neck, which is ordinarily hidden by the feathers.

"ALCIPPE CINEREA Blyth."

"*Alcippe cinerea*, BLYTH, J. A. S. Beng., XIII, p. 384" (Sharpe, Catal. Birds Brit. Mus., VII, 1883, p. 622).

An adult male from Tapanuli Bay. Length, 153 mm. "Iris brownish gray; feet fleshy brown; bill dark horn brown, pale leaden at base beneath."

I am unable at present to consult Blyth's paper; my recollection is that he did not intend to name a new species, but merely included what he thought to be Eyton's *Malacopteron cinereus* in his new genus *Alcippe*.

MALACOPTERON MAGNIROSTRE (Moore).

Alcippe magnirostris MOORE, in Horsfield and Moore, Catal. Birds Mus. East India Co., I, 1854, p. 407 (Malacca).

Three males from Pulo Mansalar and Tapanuli Bay. The length of the wing varies from 77 to 81 mm.

MALACOPTERON NOTATUM Richmond.

Malacopteron notatum RICHMOND, Proc. Biol. Soc. Wash., XV, August 6, 1902, p. 190 (Pulo Bangkaru, Banjak Islands).

Five specimens from Pulo Bangkaru. "Iris brown; bill dark brown, leaden beneath; feet leaden." It was found to be "common on both Tuangku and Bangkaru.

In the original description this species was compared, in part, with "*M. cantori* (Moore);" this should have been "*M. magnirostre* (Moore)."

CHALCOPARIA SINGALENSIS (Gmelin).

[*Motacilla*] *singalensis* GMELIN, Syst. Nat., I, Pt. 2, 1788, p. 964 ("in insula Zeylon").

One adult female from Tuangku. Length, 108 mm. "Iris red." The lower surface in this specimen is of a brighter yellow than in four females from the Malay Peninsula.

Family MUSCICAPIDÆ.

MUSCITREA GRISOLA (Blyth).

T[ephrodornis] grisola BLYTH, Journ. Asiat. Soc. Bengal, XII, Pt. 1, 1843, p. 180* ("near Calcutta").

One female from Simalur, where it was "not plentiful." Length, 165; wing, 86; culmen, 14.5 mm. This specimen agrees fairly well with the description of *Pachycephala randi polli* Finsch,[a] a species from the Batoe Islands said to be nearly related to *M. grisola*. Our bird, however, can be matched by examples from Lingga and the Natunas both in color and dimensions.

HYPOTHYMIS ABBOTTI Richmond.

Hypothymis abbotti RICHMOND, Proc. Biol. Soc. Wash., XV, August 6, 1902, p. 189 (Pulo Babi, west coast of Sumatra).

Seven specimens, from Babi and Lasia. Length, male, 178 to 187; female, 178 mm.

The male, as originally described, is wholly blue, without the black occipital spot and band across foreneck of *H. azurea*. The color is bright light cyanine blue (of Ridgway's Nomenclature of Colors), with a tinge of deep campanula blue on breast, abdomen, and sides. Wings and tail black, with a bluish shade above; under wing-coverts and axillaries, dusky gray, with bluish tips; wing feathers, from below, with dusky gray edges.

Length (in flesh), 181 mm.; wing, 76; tail, 77; tarsus, 19; culmen, 13 (bill from gape, 20). In another male the wing measures 79 mm.

"Iris blackish; feet dull leaden blue; bill blue, tip and a narrow line along commissure black; inside of mouth yellow."

While there is no visible black nape patch, or black band across the chest, the feathers of these areas have black tips on their *under* surfaces.

The female has the head, neck, and throat as in the male, but duller; the thighs and bend of wing are of the same color. The remainder of the plumage is brownish black, with a blue wash, most prominent on breast and center of abdomen, less so on back, wing-coverts, outer edges of primaries, and tail feathers. Wing, 78 mm.

The immature male is like the female, but the thighs are dusky, while the wing-coverts and secondaries (possibly new, adult feathers) are similar to those of the adult male.

From its solid blue color this species appears to be considerably larger than *H. azurea*, but in its various dimensions it hardly exceeds specimens of the latter from the Anambas and Tambelans. *H. abbotti* was "common" on Lasia, and on Babi it was "the commonest bird."

[a] Notes, Leyd. Mus., XX, p. 224.

HYPOTHYMIS AZUREA (Boddaert).

Muscicapa azurea BODDAERT, Tabl. Pl. Enl., 1783, p. 41 ("Philippines").

Five specimens, from Tapanuli Bay, Pulo Tuangku, and Bangkaru. Males from the Banjak Islands (length, 165; wing, 72–73) are just a trifle larger than those from Tapanuli Bay (length, 162; wing, 71–72), and have a bluish wash on the under tail-coverts. This species is reported as common on the Banjak Islands.

"Feet dull leaden blue; bill blue; tip black; inside of mouth yellowish green."

HYPOTHYMIS CONSOBRINA Richmond.

Hypothymis consobrina RICHMOND, Proc. Biol. Soc. Wash., XV, August 6, 1902, p. 189 (Simalur Island, west coast of Sumatra).

Two adult males, from Simalur, where it was "common." *H. tytleri* has reen recorded from Engano by Salvadori, but the bird from that island will doubtless prove to be *H. consobrina*.

"Bill blue, black at tip; inside of mouth yellow; feet leaden blue."

RHIPIDURA JAVANICA (Sparrman).

Muscicapa javanica SPARRMAN, Mus. Carls., Pt. 3, 1788, pl. LXXV (Java).

One adult male, from Loh Sidoh Bay.

TCHITREA PROCERA, new species.

Type.—Adult male, No. 179415, U.S.N.M.; Simalur Island, west coast of Sumatra, December 12, 1901; Dr. W. L. Abbott. This species closely resembles *T. nicobarica* in the white plumage, but has shorter wings, and the color of the head is glossy blue black, without a greenish sheen.

Length, 445; wing, 86; tail, 320; tarsus, 17.5; culmen, 17 (bill, from gape, 26.5) mm. "Iris dark brown; eyelids blue; inside of mouth green; bill blue, tip and commissure black; feet leaden blue."

The central rectrices in *procera* are broad, as in *nicobarica* and *floris*, not much narrowed as in *affinis* and *incii*. The wings of *nicobarica*, *affinis*, *incii*, *floris*, *sumbaënsis*, and *insularis* are 90 mm. or over; in *procera* they vary from 81 to 87 (both sexes). In *affinis*, *incii*, *nicobarica*, and *floris* (I have not seen the others) the head is of about the same shade of glossy greenish black, but it is glossy bluish black in *procera*. In *nicobarica* the feathers of the mantle are white, almost to the base, with narrow black shaft lines; in *procera* they are similar, but a little darker at the base; in *affinis* and *incii* these feathers are largely dark gray at the base, with the shaft stripes broader and more pronounced in the last-named. It has been stated that *T. incii* has no white plumage, but we have several in this phase from the Malay Peninsula, and one from north China.

The female and immature male (with short tail) of *T. procera* resemble the female of *T. nicobarica*, having the back brown (between wood brown and tawny olive), instead of cinnamon rufous, as in *T. affinis;* the under tail-coverts are russet, and the abdomen, sides, and flanks are pale buffy cinnamon, like *nicobarica*, not white as in *affinis*. They may be distinguished from *nicobarica* by the rather bluer shade of the cap, while the young male has a gray throat, lores, and sides of head, as in the females, not glossy greenish black as in the young male of *nicobarica*.

The white plumage of *T. insularis*, if it has one, does not appear to have been described. In the dark phase the cap is gray, instead of black; it has a longer wing (93 mm.), but shorter tail than *T. procera*.

Six specimens, from Simalur, where it was found to be "common."

PHILENTOMA VELATUM (Temminck).

Drymophila velata TEMMINCK, Pl. Col., III (Pt. 56), March, 1825, pl. CCCXXXIV ("Timor; et isolément ou par paire dans celle de Java").

One pair, from Tapanuli Bay. Length, 203; wing, of male, 104; of female, 99 mm.

RHINOMYIAS PECTORALIS (Salvadori).

Alcippe pectoralis SALVADORI, Atti. R. Acc. Sci. Tórino, III, 1868, p. 530 (Borneo).

One adult, from Pulo Mansalar. Length, 162; wing, 81; tail, 68 mm. "Iris brown; bill black; feet purplish fleshy." This specimen is very like one from Lingga, in color, but the bill is a little larger.

CULICICAPA CEYLONENSIS (Swainson).

Platyrhynchus ceylonensis SWAINSON, Zool. Illustr., I, No. 3, December, 1820, pl. XIII (Ceylon).

Two males, from Simalur. "Common."

Family TURDIDÆ.

PRINIA, species.

One male, from Loh Sidoh Bay. "Iris brownish gray; feet pale brownish fleshy."

This bird is in very poor plumage, with the feathers of the tail worn down to the shafts. It resembles *P. flaviventris*, but is much less greenish olive on the back, and has no yellow on the underparts, which are white with a slight buffy tinge. The tail is very long, measuring (although much abraded) 85 mm.; wing, 50 mm.

? ORTHOTOMUS ATROGULARIS Temminck.

Orthotomus atrogularis TEMMINCK, Pl. Col., III (Pt. 101), 1836, text only (Malacca, Borneo).

"Common" on Tuangku, but no specimens were preserved.

CISTICOLA CISTICOLA (Temminck).

Sylvia cisticola Temminck, Manuel d'Orn, 2d ed., I, 1820, p. 228 (Portugal).

Three males, from Simalur, where it was "common in the paddy fields and in long grass."

KITTACINCLA MELANURA Salvadori.

Cittocincla melanura Salvadori, Ann. Mus. Civ. Genova, 2d ser., IV, 1886, p. 549, pl. VIII, fig. 1 (Nias Island).

Five specimens, from Simalur, Babi, and Lasia.

These specimens are smaller than typical *K. melanura*, having a wing measurement of 86–95 mm.; for the Nias bird Salvadori gives 95–97 mm. In our birds the outermost tail feather has a bare suggestion of white at the tip. Length, male, 258–286; female, 216–241. The two females in this series are slightly paler on the underparts than the males.

"Iris dark brown; feet dull purplish brown; bill black."

On Simalur the species was found to be "not very common, and very shy." It was "common, but very shy," on Babi and Lasia.

KITTACINCLA MALABARICA (Scopoli).

Muscicapa (*malabarica*) Scopoli, Del. Flor. Faun. Insubr., II, 1786, p. 96 (based on "Le gobe-mouche à longue queue de Gingi" of Sonnerat, Voy. aux Indes, etc., II, p. 196; Malabar).

Five adult males, from Pulo Mansalar, Tuangku, and Bangkaru.

In color these birds can be matched with examples from various islands in the China Sea, from the Mergui Archipelago, etc., but two of them have unusually long tails, measuring 198 and 218 mm. The wing measurement (five males) varies from 95 to 99 mm.

"Common" in the Baujak Islands.

The name *malabarica* antedates both *tricolor* and *macroura*, and is of unquestionable application, but Scopoli's reference to "tab. 111" of Sonnerat's work is erroneous.

COPSYCHUS SAULARIS MUSICUS (Raffles).

Lanius musicus Raffles, Trans. Linn. Soc. Lond., XIII, Pt 2, 1822, p. 307.[a]

Five specimens from Loh Sidoh Bay and Simalur.

It was "common about clearings" on Simalur.

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[a] It appears to me doubtful whether Raffles's name should be used for this form. He certainly did not give a recognizable description, and apparently had no intention of describing a new species, as will be seen from his account: "The Dial Bird, or *Turdus mindanensis* of Gmelin and *Gracula saularis* of Linnæus; now with more propriety placed under *Lanius*.

It is one of the few singing birds of India, and its note is pleasing. It is about eight inches and a half in length. In the female the feathers of the throat and breast are whitish, mottled with grey and brown; and several of the wing-coverts are also white with reddish-brown shades. All the colours are duller than in the male."

Family HIRUNDINIDÆ.

HIRUNDO GUTTURALIS Scopoli.

Hirundo (*gutturalis*) Scopoli, Del. Flor. Faun. Insubr, II, 1786, p. 96 (Antique, western Panay, Philippines).

Two specimens, from Simalur, where it was "common." It was also noted as "common" on Tuangku.

Family CAMPEPHAGIDÆ.

GRAUCALUS BABIENSIS, new species.

Type.—Adult female, No. 179220 U.S.N.M.; Pulo Babi, west coast of Sumatra, January 13, 1902; Dr. W. L. Abbott. Head, back, scapulars, rump, and upper tail-coverts gray (No. 7 of Ridgway's Nomenclature), the feathers of the rump and upper tail-coverts indistinctly edged with grayish white; underparts gray, like the back, but slightly paler, becoming still lighter on the abdomen, which is unbarred; thighs gray, like the back; under tail-coverts grayish white, with obscure grayish bars; under wing-coverts white, with blackish bars; axillaries pale gray, with dusky grayish bars; wings black, the lesser, middle, and greater coverts and outer webs of tertiaries, secondaries, and of primary coverts gray like the back; inner primaries washed on edge of outer webs with the same color; under surface of wings pale gray, with a whitish line on edge of inner webs of inner primaries. Tail black, the middle pair of feathers with a wash of dark gray, the outermost pair with grayish tips.

Length, 305; wing, 168; tail, 117.5; tarsus, 29; exposed culmen, 28 (bill, from gape, 41); width of bill at base, 20 mm. "Iris pale yellow; bill and feet black."

A second female measures: Length, 318; wing, 170; tail, 123 mm. This is a large bird, like *G. kannegieteri*, but the lower breast and abdomen are entirely unbarred; there are no *black* bars on the upper tail-coverts, and the iris is pale yellow instead of white. "Common. Larger and differently colored from that of Simalur."

GRAUCALUS SIMALURENSIS, new species.

Type.—Adult male, No. 179215, U.S.N.M.; Simalur Island, west coast of Sumatra, November 19, 1901; Dr. W. L. Abbott.

This species is very like the female of *G. babiensis* (the shade of gray on the upper and lower surfaces is exactly the same as in that species), but smaller; the under tail-coverts and axillaries are unbarred, and there are only a few obscure grayish bars on the under wing-coverts.

Length, 299; wing, 166; tail, 121; tarsus, 26; exposed culmen, 26 (bill, from gape, 39.5); width of bill, at base, 20 mm. "Iris pale greenish white; bill and feet black."

The female differs from the male in having the under wing-coverts and axillaries white, conspicuously barred with slaty black; the under tail-coverts are grayish white, less plainly barred with gray and darker slate; the breast is like that of the male, but on the abdomen and flanks there are almost obsolete bars of gray (the bars being of about the same shade as the breast). Wing, 165–167 mm.

An obviously younger female has the primaries, primary-coverts, and secondaries narrowly edged with white; the rump and upper tail-coverts are barred with blackish slate and tipped with white; the breast and abdomen are white, with slaty black bars, mingled on the breast with new, unbarred, gray feathers.

The male resembles that of *G. sumatrensis* and *G. bungurensis*, but is a little paler, both above and below, and the under wing-coverts are obscurely barred. It is larger than *G. sumatrensis*, and about the size of *G. bungurensis*, but the bill is longer and broader (about 18 mm. broad in *bungurensis*, and 20 mm. in *simalurensis*).

"Common in the forest, generally in parties of three to five."

In addition to *G. babiensis* and *G. simalurensis*, the following species, related to *G. sumatrensis*, have been described from islands off the west coast of Sumatra: *G. crissalis* Salvadori (Mentawei group), *G. enganensis* Salvadori (Engano), and *G. kannegieteri* (Büttikofer) from Nias.

CAMPEPHAGA COMPTA, new species.

Type.—Adult female, No. 179222, U.S.N.M.; Simalur Island, west coast of Sumatra, November 28, 1901; Dr. W. L. Abbott.

Top of head, lores, nape, back, scapulars, rump, and upper tail-coverts bluish slate color, the feathers of the rump and upper tail-coverts with narrow white tips, immediately preceded by still narrower obscure blackish slate bars; some of the feathers of the crown with blackish centers; a narrow fringe of feathers on the forehead, a distinct line over the lores, eyes, and above ear-coverts, white; ear-coverts and malar region white, with conspicuous bluish slate stripes (darker than the upper surface); a broad line between ear-coverts and white superciliary stripe dark bluish slate color; entire under parts, including sides of neck, under wing-coverts and axillaries, white, prominently barred with slaty black, with a grayish suffusion on the sides (thighs almost uniform slate); the black and white spaces on the under surface are of nearly equal width, except on the axilliaries, under wing-coverts and under tail-coverts, where the white spaces are much wider than the black ones; on the under tail-coverts the black markings are mainly U-shaped. Wings black, the coverts, secondaries, and tertiaries with the outer webs washed with bluish slate color; feathers of the inner greater coverts and secondaries with a narrow white border on the outer webs; primaries and primary coverts black, with a narrow dark-gray edging to most of

the feathers; secondaries obscurely and very narrowly tipped with white: under surface of inner primaries largely white on basal half of inner webs (some of the secondaries also edged with white). Tail black, the middle pair of feathers washed with bluish gray, except at the tip; some of the other feathers edged with gray, and all of them tipped with white, the middle feathers very narrowly so, the white becoming more extensive toward the outermost pair, on which there is a narrow white line bordering the shaft on the outer web, extending almost to the base.

Length, 203; wing, 101; tail, 85; tarsus, 21; culmen, 14 (bill, from gape, 21) mm. "Iris clear brown; bill black, pale brown beneath, at base."

Another female, apparently a younger bird, is less distinctly barred on the breast, abdomen, and sides, these areas being much suffused with gray.

In this species the color of the under parts suggests that of the lower breast in *Graucalus sumatrensis* (typical); on the upper parts *C. compta* is of a darker and clearer color.

This species is related to *C. neglecta*, but is darker above, much more strongly barred below, has a distinct white superciliary stripe, etc.

PERICROCOTUS FLAMMIFER Hume.

[*Pericrocotus*] *flammifer* HUME, Stray Feathers, III, No. 4, May, 1875, p. 321, note (Pakchan, Tenasserim).

Ten specimens, from Simalur, where "common."

The males are identical in color with *P. flammifer* from Tenasserim and Trong, but they average slightly larger. I have no females for comparison with the three contained in the present collection, but these appear to be very dark above (almost slaty black, with a slight gloss), not "ashy brown tinged with green," as described by Oates.[a]

Length, males, 190–207; wing, 90–94; tail, 81.5–88 mm. Females are smaller, measuring, length, 190–197; wing, 87–89; tail, 80–82 mm. "Iris dark brown; bill and feet black."

PERICROCOTUS IGNEUS Blyth.

P[*ericrocotus*] *igneus* BLYTH, Journ. Asiat. Soc. Bengal, XV, 1846 (1847 ?), p. 309 (Malacca).

Two males, from Simalur.

These have rather long wings (78–80 mm.), and the two middle pairs of rectrices are wholly black. In the descriptions of *P. igneus*, given by both Sharpe and Oates, the two central feathers are said to be black, the next pair with an "orange-red mark at the tip,"[b] or "with some red at the tip."[c]

[a] Birds Brit. Burmah, I, p. 237. [b] Sharpe, Catal. Birds, IV, p. 78.
[c] Oates, Fauna Brit. India, Birds, I, p. 485.

Length, 168–172; wing, 78–80; tail, 75–76; bill, from gape, 17 mm. "Apparently not common, but several that were shot were lost in the dense underbrush."

P. igneus has been recorded from Nias.[a]

Family DICRURIDÆ.

DISSEMURUS BRACHYPHORUS (Bonaparte).

E[dolius] brachyphorus "TEMM." BONAPARTE, Consp. Gen. Avium, I, 1850, p. 351 (Borneo).

Ten specimens, from Loh Sidoh Bay, Simalur, Babi, and Lasia, those from the last-named island having longer tails and wings than the others. The dimensions of this series are given below:

Measurements of Dissemurus brachyphorus.

Locality.	Sex.	Length.	Wing.	Tail.	Bill.[a]
		Mm.	*Mm.*	*Mm.*	*Mm.*
Loh Sidoh Bay	Male	470	148	301	35
Simalur Island	Female	445	136	287	32
Do	Male	474	139	306	32
Do	do	474	138	307	34.5
Pulo Babi, Flat Islands	Female		141		36
Do	Male		145		39.5
Do	do	540	153	363	37
Pulo Lasia, Flat Islands	do	521	152	347	35.5
Do	do	534	154	370	37
Do	do	540	152	367	37

[a] Bill, from gape.

The Simalur birds have less of a greenish gloss than those from Loh Sidoh Bay and the Flat Islands, but otherwise the color is about the same. In length of wing the birds from Babi and Lasia are approached and even exceeded by others from widely different localities, but no specimens in our series (from the Natunas and Anambas; Pulo Tioman; Lankawi; Lingga, etc.) have tails quite as long as these Flat Islands examples.

"Common in the forest" on Simalur; also "common" on Babi, and "common, apparently larger than that of Simalur" on Lasia.

BUCHANGA ATRA (Hermann).

Muscicapa atra HERMANN, Obs. Zool., March, 1804, p. 208 (Tranquebaria).

One adult male, from Tapanuli Bay. Length, 279; wing, 142; tail, 124 mm.

BUCHANGA CINERACEA (Horsfield).

Edolius cineraceus HORSFIELD, Trans. Linn. Soc. Lond., XIII, Pt. 1, May, 1821, p. 145 (Java).

Six adults, from Simalur, where it was "common about clearings, sitting on dead trees. Less common in forest." Length, 257–280 mm.

[a] Büttikofer, Notes Leyd. Mus., XVIII, p. 177.

Family LANIIDÆ.

LANIUS TIGRINUS Drapiez.

Lanius tigrinus Drapiez, Dict. Class. d'Hist. Nat., XIII, 1828, p. 523 (Java).

Two males, from Simalur, where it was "not common." Length, 178 mm. "Iris dark brown."

PLATYLOPHUS CORONATUS (Raffles).

Lanius coronatus Raffles, Trans. Linn. Soc. Lond., XIII, Pt. 2, 1822, p. 306 (Sumatra).

Three specimens, from Tapanuli Bay. Length, 270 (female) to 280 (male) mm. "Feet leaden blue."

Family ORIOLIDÆ.

ORIOLUS MUNDUS, new species.

Type.—Adult male, No. 179268, U.S.N.M.; Simalur Island, west coast of Sumatra, November 19, 1901; Dr. W. L. Abbott. General color bright lemon yellow, inclining to cadmium yellow, especially on back, breast, and sides of neck; paler on greater wing-coverts, axillaries, under wing-coverts, abdomen, and under tail-coverts; wing feathers, including alula, black; third to sixth primaries very narrowly edged with white on outer webs; secondaries with almost obsolete pale yellow tips, the yellow extending down the shaft on the innermost feather; primary coverts all black, without a yellow speculum; under surface of primaries with a narrow white border on inner webs. Lores, a line over and under the eye, passing back to and including the nape, black (the black 11 mm. wide, on nape); middle tail feathers black, narrowly tipped with yellow, and very narrowly edged with yellow on both webs for a short distance; remainder of tail black, tipped with yellow, the outermost feathers black on basal half, the inner ones with the black extending progressively toward the tips.

Length, 280; wing, 151; tail, 103; tarsus, 26; culmen, 35 (bill, from gape, 40 mm.). "Iris dull red; feet leaden."

The female is duller than the male, with a greenish-yellow wash on the back, central tail feathers, wing-coverts, and outer webs of tertiaries.

Oriolus mundus belongs to the black-naped section of the genus, in the group of species having no wing speculum, but it is not very nearly allied to any described species. It differs from most, if not all, of the members of this group in having the back and mantle clear rich yellow, not sordid or greenish.

Four specimens, from Simalur.

ORIOLUS MACULATUS Vieillot.

Oriolus maculatus Vieillot, Nouv. Dict. d'Hist. Nat., XVIII, 1817, p. 194 (Java).

One adult female, from Loh Sidoh Bay. Length, 260; wing, 142 mm. "Iris red."

Family CORVIDÆ.

PLATYSMURUS LEUCOPTERUS (Temminck).

Glaucopis leucopterus TEMMINCK, Pl. Col., II (Pt. 45), April, 1824, pl. CCLXV (Sumatra).

Three adults, from Tapanuli Bay. Length, 407–438; wing (male), 197–199, (female) 181 mm. "Iris deep red; inside of mouth white."

CORVUS COMPILATOR, new name.

Three specimens, from Simalur, where "tolerably abundant and not at all shy." Length, 445–457 mm. "Iris dark brown."

Corvus tenuirostris Moore,[a] used for this form by Büttikofer,[b] is preoccupied by *C. tenuirostris*, C. L. Brehm,[c] and as no other name appears to be available, I have given it a new one.

Family STURNIDÆ.

AGROPSAR STURNINA (Pallas).

Gracula sturnina PALLAS, Reise Russischen Reichs, III, 1776, p. 695 ("In salicetis Dauuriae australioris, circa Ononem et Argunum").

One immature female, from Simalur. "A flock seen at Sibabo."

Family EULABETIDÆ.

LAMPROCORAX ALTIROSTRIS (Salvadori).

Calornis altirostris SALVADORI, Ann. Mus. Civ. Genova, 2d ser., IV, 1887, p. 553, pl. IX, fig. 1 (Nias Island).

Four specimens, from Simalur and Pulo Babi.

Dr. Sharpe thought this form might be closely related to *L. tytleri*,[d] but *tytleri* has the small bill of *chalybea*, with green, rather than bronzy, upper parts, and differs also in size and in the more prominent lanceolate feathers surrounding the head. In other words, *L. altirostris* is allied to *L. chalybea* rather than to *L. tytleri*.

Lamprocorax altirostris was seen on Pulo Lasia, and "common" on Babi; on Simalur it was "common, especially on the small islets."

The measurements of the specimens are given below:

Measurements of Lamprocorax altirostris.

Locality.	Sex.	Length.	Wing.	Tail.
		Mm.	*Mm.*	*Mm.*
Simalur Island	Male	207	100	62.
Pulo Babi	do	213	105	65.
Do	Female	216	100	62.
Do	do	210	100	63.

[a] Catal. Birds Mus. E. I. Co., II, 1856–58, p. 558.

[b] Notes Leyden Mus., XVIII, 1896, p. 185.

[c] Vollständige Vogelfang, 1855, p. 57.

[d] Catal. Birds, XIII, p. 147.

EULABES JAVANUS Cuvier.

Eulabes javanus CUVIER, Règne Animal, 2d ed., I, 1829, p. 377 (Java).

Six specimens, from Simalur, with lappets larger, and the fleshy portion which passes anteriorly toward the eye wider, than in true *javanus;* but in color and measurements these Simalur birds can be matched by individuals from various localities. "Iris dark brown; feet yellow; wattles bright yellow." Length, 299–318 mm.

EULABES ROBUSTA (Salvadori).

Gracula robusta SALVADORI, Ann. Mus. Civ. Genova, 2d ser., IV, 1887, p. 554, pl. IX, fig. 2 (Nias Island).

Eight specimens, from Babi and Tuangku. Length, 343–372 mm. "Iris dark brown; bill red at base, yellow at tip; feet and wattles yellow; claws horn brown, base whitish."

This species was found to be "common" on Pulo Babi, and on both of the Banjak Islands (Tuangku and Bangkaru).

Family NECTARINIIDÆ.

ARACHNOTHERA FLAVIGASTRA (Eyton).

Anthreptes flavigaster EYTON, Proc. Zool. Soc. Lond., 1839, p. 105 ("Malaya").

An adult male, from Tapanuli Bay. Length, 197; wing, 97; culmen, 39 mm. "Iris dark brown; bill dark horn brown, paler beneath, at base."

ARACHNOTHERA CHRYSOGENYS (Temminck).

Nectarinia chrysogenys TEMMINCK, Pl. Col., IV (Pl. 65), May, 1826, pt. CCCLXXXVIII, fig. 1 (Java).

Three adult males, from Tapanuli Bay. Length, 178; wing, 87–88 mm. "Iris dark brown; bill black, with a narrow dull yellow line on edges of both mandibles; angles of mouth white; feet pale brownish fleshy."

ARACHNOTHERA LONGIROSTRIS (Latham).

[*Certhia*] *longirostra* LATHAM, Index Ornith., I, 1790, p. 299 (Bengal).

Three specimens, from Bangkaru and Tuangku. Length, of male, 171–174; wing, 67–69; culmen, 41–43; of female, length, 156; wing, 62; culmen, 37 mm. The bills of these individuals are rather longer than those of Malay Peninsula birds. "Common" on Tuangku.

ARACHNOTHERA MODESTA (Eyton).

Anthreptes modesta EYTON, Proc. Zool. Soc. Lond., 1839, p. 105 ("Malaya").

Three adult males, from Loh Sidoh Bay and Tapanuli Bay. Length, 172; wing, 80–82 mm. "Iris dark brown; feet pale brownish fleshy; bill dark horn brown above, paler beneath."

ANTHREPTES MALACENSIS (Scopoli).

Certhia (malacensis) Scopoli, Del. Flor. Faun. Insubr., II, 1786, p. 91 (Malacca).

Five adults, from Simalur, where "common about cocoanut plantations." These are perceptibly longer than Malay Peninsula examples, but color is identical. Length, 134–143 mm.

ARACHNECHTHRA BRASILIANA (Gmelin).

[Certhia] brasiliana Gmelin, Syst. Nat., I, Pt. 1, 1788, p. 474 ("Brasilia").

One adult male, from Simalur. Length, 108; wing, 49; culmen, 16 mm. This specimen agrees in all respects, except that of bill, with birds from other localities. Ordinarily the culmen measures about 12 mm., but in this individual it is 16 mm. Some specimens from islands in the China Sea have long bills, but they do not quite match this Simalur bird.

"Not very common." Also seen on Tuangku.

ÆTHOPYGA SIPARAJA (Raffles).

Certhia siparaja Raffles, Trans. Linn. Soc. Lond., XIII, Pt. 2, 1822, p. 299 (Sumatra).

Twelve specimens, from Tapanuli Bay, Simalur, Babi, Lasia, and Bangkaru. The males from Babi and Lasia are a little darker on the abdomen than any others in our collection, and the color of the female is rather brighter than in those from other localities.

On Simalur it was "generally in thick jungle about the edges of clearings, and in cocoanut plantations. Most plentiful on Pulo Baba in Telok Dalam." It was "common at edge of jungle on the shore" of Lasia, Babi, and on the Banjak Islands.

CHALCOSTETHA INSIGNIS (Jardine).

Nectarinia insignis Jardine, Naturalist's Libr., XXXVI (Birds, XIII), 1843, p. 274 (Java).

Four specimens, from Simalur and Tapanuli Bay. On Simalur it was "common in the mangroves about Telok Dalam."

Family DICÆIDÆ.

DICÆUM TRIGONOSTIGMA (Scopoli).

Certhia (trigonostigma) Scopoli, Del. Flor. Faun Insubr., II, 1786, p. 91 ("Chine").

Three specimens, from Simalur and Lasia. At the first-named island it was "common."

Family PLOCEIDÆ.

MUNIA MAJA (Linnæus).

[Loxia] maja Linnæus, Syst. Nat., 12th ed., I, 1766, p. 301 (Malacca).

Five from Loh Sidoh Bay and three from Simalur. It was found "in large flocks upon the fields of paddy" on Simalur.

IST OF SPECIES MENTIONED IN THE PRECEDING CATALOGUE, BY LOCALITIES.

LOH SIDOH BAY.

ierohierax fringillarius.
udynamys honorata malayana.
hænicophaüs erythrognathus.
Ialcyon armstrongi?.
allolophus malaccensis.
iga javanensis.
endronanthus indicus.
rachycomus ochrocephalus.
ycnonotus analis.
Pycnonotus simplex.
Rhipidura javanica.
Prinia, sp.
Copsychus saularis musicus.
Dissemurus brachyphorus.
Oriolus maculatus.
Arachnothera modesta.
Munia maja.

SIMALUR ISLAND, INCLUDING PULO ASU AND PULO SIUMAT.

haradrius dominicus fulvus.
chthodromus geoffroyi.
chthodromus pyrrhothorax.
allinago stenura.
otanus totanus eurhinus.
ctitis hypoleucos.
eimonites ruficollis.
Vumenius phæopus.
renaria interpres.
Esacus magnirostris.
Iypotænidia striata.
maurornis phœnicurus.
rdea sumatrana.
Demiegretta sacra.
Butorides javanica.
rdeola, species.
Treron vernans.
Carpophaga consobrina.
Myristicivora bicolor.
Columba phasma.
Macropygia simalurensis.
Chalcophaps indica.
Calœnas nicobarica.
stur soloënsis.
ccipiter virgatus.
Spizaëtus alboniger.
Haliæetus leucogaster.
Spilornis abbotti.
Haliastur indus intermedius.
Falco peregrinus?.
Pisorhina umbra.
Palæornis fasciatus.
Psittinus abbotti.
Cacomantis sepulcralis.
Eudynamys honorata malayana.
Eurystomus calonyx.
Melittophagus urica.
Merops philippinus.
Pelargopsis simalurensis.
Alcedo ispida bengalensis.
Alcedo meninting.
Ceyx, species.
Halcyon coromanda.
Halcyon pileata.
Halcyon chloris?.
Thriponax parvus.
Macropteryx perlonga.
Salangana fuciphaga.
Dendronanthus indicus.
Motacilla melanope.
Budytes flavus leucostriatus.
Microtarsus melanocephalos.
Muscitrea grisola.
Hypothymis consobrina.
Tchitrea procera.
Culicicapa ceylonensis.
Cisticola cisticola.
Kittacincla melanura.
Copsychus saularis musicus.
Hirundo gutturalis.
Graucalus simalurensis.
Campephaga compta.
Pericrocotus igneus.
Pericrocotus flammifer.
Dissemurus brachyphorus.
Buchanga cineracea.
Lanius tigrinus.
Oriolus mundus.
Corvus compilator.
Agropsar sturnina.
Lamprocorax altirostris.
Eulabes javanus.
Anthreptes malacensis.
Arachnechthra brasiliana.
Æthopyga siparaja.
Chalcostetha pectoralis.
Dicæum trigonostigma.
Munia maja.

THE FLAT ISLANDS.

PULO BABI AND PULO LASIA.

Esacus magnirostris (B.).
Ardea sumatrana (B.).
Carpophaga consobrina (B. L.).
Myristicivora bicolor (B. L.).
Chalcophaps indica (B.).
Calœnas nicobarica (B.).
Accipiter virgatus (L.).
Haliæetus leucogaster (B. L.).
Palæornis major (B. L.).
Eudynamys honorata malayana (B. L.).
Halcyon coromanda (L.).
Halcyon pileata (B.).
Hypothymis abbotti (B. L.).
Kittacincla melanura (B. L.).
Graucalus babiensis (B.).
Dissemurus brachyphorus (B. L.).
Lamprocorax altirostris (B. L.).
Eulabes robusta (B.).
Æthopyga siparaja (B. L.).
Dicæum trigonostigma (L.).

THE BANJAK ISLANDS.

PULO BANGKARU.

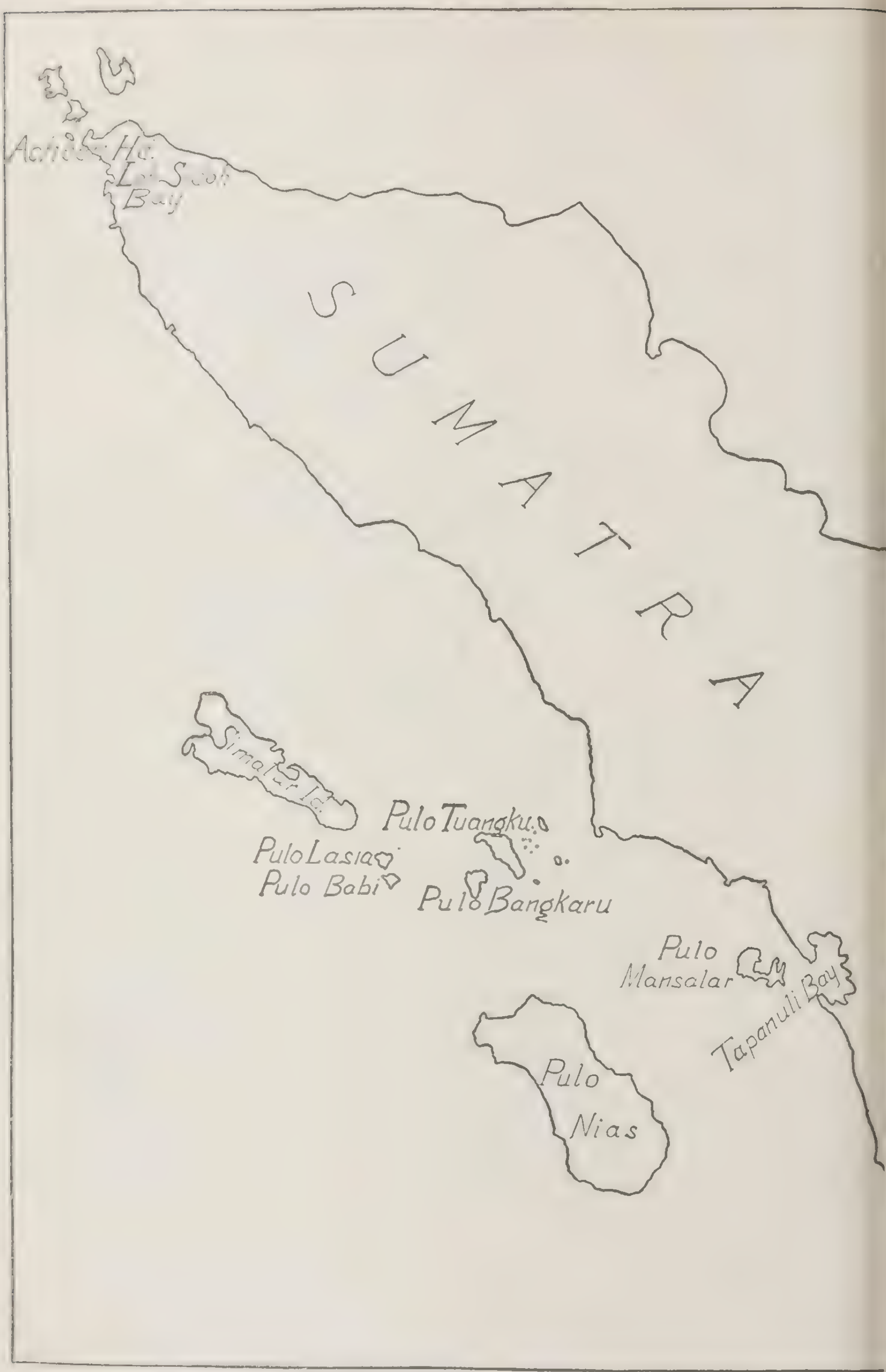
Spizaëtus, species.
Haliæetus leucogaster.
Syrnium niasense.
Ceyx, species.
Dendronanthus indicus.
Pycnonotus simplex.
Mixornis pileatus.
Malacopteron notatum.
Hypothymis azurea.
Kittacincla malabarica.
Eulabes robusta.
Arachnothera longirostris.
Æthopyga siparaja.

PULO TUANGKU.

Numenius arquatus.
Esacus magnirostris.
Ardea sumatrana.
Demiegretta sacra.
Treron, species.
Carpophaga consobrina.
Myristicivora bicolor.
Haliæetus leucogaster.
Haliastur indus intermedius.
Loriculus galgulus.
Merops philippinus.
Pelargopsis sodalis.
Alcedo ispida bengalensis.
Alcedo meninting.
Meiglyptes tukki.
Salangana "francica."
Eurylaimus ochromalus.
Pitta moluccensis.
Irena criniger.
Pycnonotus plumosus.
Pycnonotus simplex.
Pycnonotus erythropthalmos.
Anuropsis malaccensis.
Cyanoderma fulviventris.
Stachyris banjakensis.
Malacopteron notatum.
Chalcoparia singalensis.
Hypothymis azurea.
Orthotomus atrogularis?.
Kittacincla malabarica.
Hirundo gutturalis.
Eulabes robusta.
Arachnothera longirostris.
Arachnechthra brasiliana.
Æthopyga siparaja.

TAPANULI BAY, INCLUDING PULO MANSALAR.

Sphenocercus oxyurus.
Butreron capellei.
Treron nipalensis.
Treron fulvicollis.
Haliaetus leucogaster.
Icthyophaga ichthyaëtus.
Spilornis bacha.
Haliastur indus intermedius.
Rhopodytes diardi.
Merops philippinus.
Pelargopsis gurial fraseri.
Alcedo ispida bengalensis.
Alcedo meninting.
Halcyon coromanda.
Halcyon pileata.
Dichoceros bicornis.
Anthracoceros convexus.
Rhytidoceros undulatus.
Anorrhinus galeritus.
Chotorhea chrysopogon.
Chotorhea mystacophanes.
Cyanops henricii.
Mezobucco duvaucelii.
Blythipicus porphyromelas.
Meiglyptes tukki.
Micropternus brachyurus.
Thriponax javensis.
Pyrotrogon duvauceli.
Macropteryx comata.
Cymbirhynchus lemniscatus.
Chloropsis cyanopogon.
Irena criniger.
Hemixus malaccensis.
Iole olivacea.
Euptilosus eutilosus.
Microtarsus melanocephalos.
Tricholestes criniger.
Pycnonotus plumosus.
Pycnonotus, species (white iris).
"*Alcippe cinerea.*"
Malacopteron magnirostre.
Hypothymis azurea.
Philentoma velatum.
Rhinomyias pectoralis.
Kittacincla malabarica.
Buchanga atra.
Platylophus coronatus.
Platysmurus leucopterus.
Arachnothera flavigastra.
Arachnothera chrysogenys.
Arachnothera modesta.
Æthopyga siparaja.
Chalcostetha pectoralis.



NORTHWESTERN SUMATRA AND ADJACENT ISLANDS.

A REVIEW OF THE SYNENTOGNATHOUS FISHES OF JAPAN.

By David Starr Jordan and Edwin Chapin Starks,

Of the Leland Stanford Junior University.

In this paper is given an account of those fishes of Japan belonging to the suborder of *Synentognathi*. The material examined belongs to the United States National Museum and to the Leland Stanford Junior University, most of it having been collected by Messrs. Jordan and Snyder during the summer of 1900.

Suborder SYNENTOGNATHI.

Lower pharyngeal bones fully united; second and third superior pharyngeals variously enlarged, not articulated to the cranium, sending processes forward; the fourth small or fused with the third. Vertebræ numerous (45 to 70), the abdominal ones much more numerous than the caudal. Ventral fins abdominal, without spine, the rays more than five. Scapula suspended to the cranium by a post-temporal bone, which is usually simple, furcate in *Belonidæ*. Articular bone of lower jaw with a small supplemental bone perhaps corresponding to the coronoid bone. Parietal bones usually absent, when present much reduced, well separated by the supraoccipital. Supraclavicle small when present; no interclavicles. No mesocoracoid. Maxillary very close to premaxillary and sometimes firmly joined to it, the suture always distinct. Basis of cranium double in front, but without muscular tube. No adipose fin. Fins without spines. Lateral line concurrent with the belly, peculiar in structure. Air bladder usually large, without pneumatic duct. Intestinal tract simple, without pyloric cæca. This order is allied to the Haplomi on the one hand and to the Percesoces on the other, and, like these groups, it marks the transition from the soft-rayed to the spiny-rayed fishes. In their anatomical characters the *Synentognathi* most resemble the latter, but there are never spines in the fins, and the lower pharyngeals are united. The group is divisible into four closely related families, which have usually been regarded as divisions of one

family, *Exocætidæ* or *Scombresocidæ*. The remarkable differences in the pharyngeals seem to us to permit the division of the group into four families.

(σύν, together; ἔν, within; γνάθος, jaw.)

a. Third superior pharyngeal on each side scarcely enlarged, not longer than its anterior process, and armed with comparatively few (about 15) pointed teeth; fourth superior pharyngeal distinct on each side; lower pharyngeals united into a small linear plate, armed with small teeth; vertebræ with zygapophyses; both jaws produced in a long beak in the adult (the upper short in the young); teeth in jaws strong, unequal; maxillaries firmly appressed to the premaxillaries; a distinct suture along the boundary; "coronoid" bone (attached to the articular) evident. Species carnivorous .... BELONIDÆ, 1.

aa. Third superior pharyngeal greatly enlarged, covered with bluntish, tricuspid teeth; fourth superior pharyngeal wanting or fused with the third; lower pharyngeals large, fused into a thick triangular bone with transversely concave surface, covered with blunt, tricuspid teeth; teeth in jaws always small, conic, or tricuspid; maxillary close to premaxillary, but not suturally joined to it, there being some open space between; coronoid bone small, but present; no canine teeth; no zygapophyses to the vertebræ.

b. Third superior pharyngeal solidly joined with its fellow to form an ovoid plate, which sends two processes forward; cleft of mouth narrow; the lower jaw usually produced; teeth of jaws tricuspid; herbivorous species. HEMIRAMPHIDÆ, 2.

bb. Third superior pharyngeals more or less closely appressed, but not united; species at least partly carnivorous.

c. Dorsal and anal fins each with several detached finlets; cleft of mouth long, both jaws being more or less produced in a pointed beak; paired fins small. SCOMBRESOCIDÆ, 3.

cc. Dorsal and anal without finlets; cleft of mouth short, the jaws not produced in a beak; pectoral fins more or less produced, forming an organ of flight. EXOCŒTIDÆ, 4.

Family I. BELONIDÆ.

NEEDLE-FISHES.

Body elongate, very slender, compressed or not, covered with small, thin scales. Lateral line very low, running as a fold along side of belly. Both jaws produced in a beak, the lower jaw the longer, very much the longer in the young, which resemble *Hemiramphus;* maxillaries grown fast to premaxillaries; each jaw with a band of small, sharp teeth, besides a series of longer, wide-set, sharp, conical teeth. No finlets. Dorsal fin opposite anal, both fins rather long. Air bladder present. Lower pharyngeals united to form a long, slender, narrow plate, with flat surface, covered with small, pointed teeth; upper pharyngeals distinct, the third pair little enlarged, each with some 15 moderate, unequal, pointed teeth (*Tylosurus marinus*); fourth pair well developed, with similar teeth, but without anterior processes. Vertebræ numerous, with zygopophyses. Ovary single. Voracious, carnivorous fishes, bearing a superficial resemblance to the gar pikes;

found in all warm seas, sometimes entering rivers. Their habits are ordinarily much like those of the pike, but when startled they swim along the surface with extraordinary rapidity, often leaping above the water for short distances. When thus leaping the large species of the tropics are sources of danger to incautious fishermen, sometimes piercing the naked abdomen of the natives. Most of them are good food-fishes, but the green color of the bones of the larger species often causes them to be avoided, for no good reason.

a. Gill rakers wanting; no teeth on vomer; anterior rays of dorsal and anal elevated. *Tylosurus*, 1.

1. TYLOSURUS Cocco.

Tylosurus Cocco, "Lettere in Giornale Sci. Sicilia, XVII," 1829, p. 18 (*cantraini=imperialis*).

Body elongate, very slender, not much compressed. Both jaws prolonged into a beak, the lower jaw somewhat the longer, much the longer in young fishes, the very young resembling *Hemiramphus*. Each jaw armed with a band of small, sharp teeth, beside which is a series of longer, wide-set, sharp, conical, unequal teeth; no teeth on vomer or palatines. Scales small, thin; lateral line running along the side of the belly, becoming median on the tail. No finlets. Dorsal fin more or less elevated anteriorly; caudal fin short, unequally lunated or forked; pectorals moderate; ventrals small, the latter inserted behind the middle of the body. Gill rakers obsolete. Bones usually more or less green. Size comparatively large. Species numerous. Voracious fishes, chiefly American; one species crossing to Europe; some of them entering rivers. This genus differs from the Old World genus, *Belone* Cuvier, in the absence of gill rakers and of vomerine teeth.

(τύλος, callus; οὐρά, tail; in allusion to the caudal keel, on which the genus was originally based, a character of little importance.)

a. Dorsal rays about 25.
  b. Lateral line not forming a black keel on caudal peduncle. Posterior dorsal rays produced to form a rounded lobe as high or nearly as high as produced anterior lobe, these rays longest in the young. Jaws slender and long; upper jaw from anterior orbital rim $2\frac{1}{2}$ times longer than length of rest of head. *schismatorhynchus*, 1.
  bb. Lateral line extending on caudal peduncle, forming a low black keel.
    c. Jaws short and stout; upper jaw from anterior orbital rim $1\frac{3}{5}$ longer than rest of head; posterior rays of dorsal elevated; size very large...... *giganteus*, 2.
    cc. Jaws slender and long; posterior rays of dorsal short; body scarcely compressed .... *coromandelicus*, 3.
aa. Dorsal rays about 18; posterior rays of dorsal short. Body much compressed, the width one-half the depth; caudal peduncle much compressed, without keel .... *anastomella*, 4.

1. TYLOSURUS SCHISMATORHYNCHUS (Bleeker).

DATSU.

Belone gracilis SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 246, pl. CX, fig. 1; Nagasaki; not of Lowe, 1839, a species from Madeira.—BLEEKER, Nieuwe Nalez., Japan, 1857, p. 116.—NYSTROM, Svensk. Vet. Akad. Handl., 1887, p. 44; Nagasaki.

Mastacembelus gracilis BLEEKER, Ned. Tyds. Dierk., 1866, p. 111.

Belone schismatorhynchus BLEEKER, Nat. Tydschr. Ned. Ind., I, 1850, p. 95.—BLEEKER, Verh. Gen., XXIV, 1866, p. 15.—GÜNTHER, Cat. Fish, VI, 1866, p. 239; Mozambique, Zanzibar.—ISHIKAWA, Prel. Cat., 1897, p. 18; Boshu.

Mastacembelus schismatorhynchus BLEEKER, Atlas Ichth. Ind. Belon., about 1870, p. 49; Java, Ternate, Nagasaki.

Head from tip of upper jaw $4\frac{1}{4}$ to $4\frac{1}{2}$ in length; depth equals postorbital part of head; dorsal 24 to 27; anal 25 to 27.

Body very elongate and rather strongly compressed, the sides vertical and parallel. Dorsal and anal outlines parallel from head to dorsal. Jaws very slender and long; upper jaw from anterior orbital rim $2\frac{1}{2}$ times longer than rest of head. Premaxillary toward base constricted slightly and strengthened above by a mass of bone along the posterior fourth of the length, which ends in a point as viewed from above. Diameter of eye equals interorbital width and is contained 2 to $2\frac{1}{4}$ in postorbital part of head. Top of head from above eyes to occiput smooth with a translucent cartilage-like tissue. Nostril an elongate, somewhat triangular pit containing a simple undivided papilla. Head apparently naked except a patch of scales above cheeks and another on top of head from eyes to base of mixillary.

Pectoral equal to postorbital part of head or sometimes slightly longer. Ventrals inserted nearer the anterior margin of the eye than the base of the caudal by a distance equal to a diameter of the eye, their length twice the diameter of the eye. Anal placed well in advance of dorsal; the base of the sixth ray under the base of the first dorsal ray, the anterior part of anal strongly concave on its posterior margin. Distance of base of last anal ray from base of auxiliary caudal rays $1\frac{1}{4}$ to $1\frac{1}{3}$ times the diameter of the eye; the last ray reaches a little over half this distance. Distance from front of anal to base of ventrals is contained 5 times in length from middle of eye to caudal base; the anal base exceeds this length by $1\frac{1}{2}$ times the diameter of the eye. Dorsal scarcely so strongly concave behind the anterior rays as anal; its longest rays are behind the middle. When fin is depressed the tip of eighth ray from the last reaches base of last ray. Distance between base of last dorsal ray and base of auxillary caudal rays equals diameter of eye; the depressed dorsal reaches five-sixths of this distance. Median caudal rays about half the length of longest rays of lower caudal lobe, which is a little longer than the upper. The lateral line is not at all produced as a keel on caudal peduncle.

Color in spirits: A bluish diffused lateral band follows the contour of back, running from the pectoral base to just above the middle of the caudal base, growing narrower posteriorly. Above lateral band the body is greenish or brownish; below uniformly bright silvery. Upper part of head dark, except translucent cartilaginous area; base of upper jaw black; head otherwise silvery. Distal half of pectoral black; outer rays and tips of ventrals dusky; anterior rays of anal dusky toward tips; dorsal blackish, except bases of anterior rays, the rays usually green; caudal dusky.

Here described from specimens from Nagasaki 45 cm. in length. Other specimens are from Wakanoura.

(σχίσμα, split; ῥύγχος, snout.)

2. TYLOSURUS GIGANTEUS (Schlegel).

OKIZAYORI (OFFSHORE NEEDLEFISH).

?*Belone indica* Le Sueur, Journ. Ac. Nat. Sci. Phila., II, 1821, p. 131; India.
Belone gigantea Schlegel, Fauna Japonica, Poiss., 1846, p. 245; Nagasaki.—Bleeker, Ac. Soc. Indo-Nederl., III, Japan, p. 21.
Belone annulata Cuvier and Valenciennes, Hist. Nat. Poiss., XVIII, 1846, p. 447; Celebes, Friendly Islands, Seychelles, Pondicherry.
Belone annulata Günther, Cat. Fish., VI, 1866, p. 240; Pinang, China.—Ishikawa, Prel. Cat., 1897, p. 18; Tokyo, Formosa.
Mastacembelus annulatus Bleeker, Atlas Ichth. Belon., 1870, p. 48; Java, Madura, Bawean, Cocos, Sumatra, Singapore, Celebes, Pinang, Batjan, Ternate, Amboina, Gilolo.
?*Belone melanurus* Bleeker, Verh. Bat. Gen., XXII, 1849, p. 11.
Belone cylindrica Bleeker, Verh. Bat. Gen., XXIV, 1851, p. 13.
?*Belone brachyrhynchus* Bleeker, Nat. Tyds. Ned. Ind., VI, 1854, p. 61; Gilolo, young.

Head from tip of lower jaw $3\frac{3}{5}$ in length; depth at ventrals $1\frac{1}{4}$ in postorbital part of head. Dorsal 23; anal 21.

Body as wide as deep to within a short distance of dorsal, the interorbital space and head above gently convex. Jaws rather short and stout, the lower slightly the longer; their sides nowhere parallel but approaching rather rapidly to a point. Length of snout from anterior margin of eye equal to the distance from same point to middle of longest pectoral rays. Eye one-third of postorbital part of head, one-half of interorbital. Interorbital space with two low ridges, separated from each other by a space equal to two-thirds diameter of eye, imperceptibly diverging anteriorly. Between them are two narrower, shorter, parallel ridges separated by a space one-third of diameter of eye. Nostrils broad, triangular, containing a fleshy process divided into many folds. Cheeks entirely scaled; scales on top of head before eyes to base of premaxillary.

Length of pectoral equals postorbital part of head and one-third eye. Length of ventrals contained $2\frac{1}{4}$ times in space between their base and front of anal. Insertion of ventrals midway between middle

of eye and base of caudal. Front of anal directly under front of dorsal, its base shorter than that of dorsal by three-fourths diameter of eye, and equal to the distance between ventrals and anal. Outline of dorsal and anal deeply concave behind anterior rays. Anterior rays of the latter longer than those of dorsal. Base of the last anal ray distant from base of auxilliary caudal rays twice the distance from last dorsal ray to the corresponding caudal ray. Anterior dorsal rays longer than the long posterior dorsal rays. When dorsal is depressed the seventh from the last ray reaches to the base of the last ray and the tips of the last few rays barely reach the base of the auxiliary caudal rays. Caudal evidently forked, the lower lobe the longer. Lateral line strongly produced on caudal peduncle forming a keel.

Silvery on sides and lower parts growing rather gradually greenish on back. Top of head and upper jaw black. A long black blotch at edge of preopercle. Dentate margin of lower jaw black; head otherwise silvery. Inner face and posterior part of outer face dusky. Ventrals dark except inner rays. Anterior ray of anal dusky. Dorsal and caudal blackish. Lateral line on caudal peduncle black.

Here described from a single specimen from Nagasaki, 33 inches in length.

A young specimen of this or some closely related species from Wakanoura differs in having the posterior rays of the dorsal lengthened to well beyond the base of caudal (when the dorsal is depressed), the caudal scarcely forked and with a black blotch at its base, the eye, of course, much larger and the general color much darker and without silvery pigment. It is but 12 cm. in length.

According to Bleeker the type of *giganteus* examined by him in the Leyden Museum is identical with *annulatus*. The name *giganteus* is apparently the earlier of the two, but *indicus*, about the pertinence of which there is some doubt, is earlier than either. A species apparently identical with these occurs in Hawaii and in Samoa.

3. TYLOSURUS COROMANDELICUS (Van Hasselt).

Belone coromandelicus Van Hasselt, Alg. Konst., 1823, p. 130; Coromandel according to Bleeker.

Belone timucoides de Ferussac, Zool., 1823, p. 372, after Van Hasselt.

Belone melanotus Bleeker, Nat. Tyds. Ned. Ind., I, 1850, p. 94.—Bleeker, Verh. Genootsch., XXIV, 1851, p. 14.—Günther, Cat. Fish., VI, 1866, p. 239; East Indies.

Mastacembelus melanotus Bleeker, Atlas Ichth. Ind. Belon., 1870, p. 47; Java, Singapore, Molucca, Celebes.

Head $3\frac{1}{2}$ in length; depth exceeds postorbital part of head by one-fourth eye. Dorsal 25 or 26; anal 23 or 24.

Body scarcely compressed. Head nearly flat between eyes. Jaws rather slender and long. Snout from anterior margin of eye equal to twice the distance from same point to edge of opercle. Eye one-ha

postorbital part of head, five-sixths of interorbital width. Interorbital rough, with longitudinal striations; a shallow groove along its middle.

Length of pectoral equals depth at ventrals, or $2\frac{2}{3}$ in dorsal base. Length of ventrals contained $2\frac{2}{3}$ times in space between their base and front of anal. Ventrals inserted midway between caudal base and posterior third of eye. Anal a little in advance of front of dorsal, its base shorter than that of dorsal by the diameter of eye. Outline of dorsal and anal deeply concave behind anterior rays. Anterior rays of dorsal equal in length to those of anal. Base of last anal ray twice the diameter of eye distant from base of auxiliary caudal rays. Last dorsal ray three-fourths eye from auxiliary caudal rays. Posterior dorsal rays not much elongated; the longest scarcely as long as eye; the third ray from the last reaches base of last ray in reclined fin; the last ray reaches three-fifths the distance between its base and base of auxiliary caudal rays. Caudal not deeply forked, the lower lobe much the longer. Lateral line on caudal peduncle slightly raised to a keel which is black.

Color in spirits: Greenish on back, silvery below; jaws and teeth green; pectoral dusky toward tips of rays; axil black; tips of front dorsal rays dusky, and dorsal black behind; tip of middle anal rays black; dorsal dusky.

Here described from a specimen 78 cm. in length from Tsuruga. Another specimen is in the collection from Yokohama.

There is no other record of the species from Japan. It is apparently frequently taken in the East Indies.

(*Coromandelicus*, from Coromandel.)

4. TYLOSURUS ANASTOMELLA (Cuvier and Valenciennes).

DATSU.

Belone anastomella Cuvier and Valenciennes, Hist. Poiss., XVIII, 1846, p. 446; China.—Günther, Cat. Fish., VI, 1866, p. 249; Shanghai, Japan, India.—Ishikawa, Prel. Cat., 1897, p. 18; Tokyo.—Steindachner and Döderlein, Fische Japans, IV, 1887, p. 37; Tokyo.

Tylosurus anastomella Jordan and Snyder, Check List Fishes, Japan, 1901, p. 61; Yokohama.

Belonia ciconia Richardson, Ichth. China, 1846, p. 264; Canton, on a drawing by Reeves.

Depth at ventral fins $1\frac{1}{5}$ in postorbital part of head, which is $9\frac{1}{3}$ in length from opercle to base of caudal. Dorsal, 18; anal, 23.

Body compressed, the width a little less than half depth. Tips of jaws broken in all our specimens; upper jaw to eye at least $3\frac{1}{5}$ from same point to base of caudal. Eye $3\frac{1}{5}$ in postorbital part of head, seven-eighths of interorbital width. Interorbital with a wide, shallow channel along its middle. Base of upper jaw not strengthened by a bony ridge, but outline of head evenly and slightly concave from

occiput to tip of jaw. Nostril as broad as deep, triangular. Suborbital space equal to depth of eye. Teeth rather slender; no teeth on palate.

Length of pectoral $1\frac{1}{4}$ in postorbital part of head. Ventrals inserted midway between base of pectoral and base of caudal, their length two-thirds that of pectoral. Base of eighth anal ray under first dorsal ray. Base of anal slightly less than space between its first ray and ventrals. Anterior anal rays longer than those of dorsal, or $1\frac{2}{3}$ in postorbital part of head. Base of last anal ray one-half diameter of eye anterior to base of last dorsal ray. Space between last anal ray and auxiliary caudal rays equal to length of anterior anal rays. Base of dorsal $1\frac{1}{4}$ in that of anal. Lower rays of caudal scarcely longer than upper rays; the caudal scarcely forked, lunate when fin is extended. Caudal peduncle compressed, without keel.

Color in spirits: A narrow bluish silvery lateral band, following outline of back, runs from above pectoral to caudal base; above the back is abruptly brownish; below the sides and belly are uniformly bright silvery; top of head dark; a dark band along posterior upper part of preopercle; tip of pectoral dusky; axil colorless; dorsal and caudal dark.

Here described from a specimen 70 cm. in length from Yokohama. Other specimens are from Tokyo, Matsushima, and Hakodate. It is not certain that the name *anastomella* is prior to *ciconia*, but the description is better.

(ἀναστόμος, sharp mouthed.)

Family II. HEMIRAMPHIDÆ.

HALF-BEAKS.

Body elongate, more or less compressed, covered with large cycloid scales; upper jaw short, lower jaw various, sometimes much produced, the toothed portion at base fitting against the toothed premaxillaries; teeth equal, mostly small and tricuspid; maxillaries anchylosed to premaxillaries. Gill rakers long. Caudal fin rounded, or forked; if forked, the lower lobe the longer. Anal fin modified in the viviparous species (*Zenarchopterus*), unmodified in the others and usually similar to the dorsal; no finlets; air bladder large, sometimes cellular. Third upper pharyngeal on each side much enlarged, solidly united with its fellow to form an oval plate, with slightly convex surface and covered with blunt tricuspid teeth; this is about as large as the united lower pharyngeals, and fits into the concavity of the latter; fourth upper pharyngeal wanting or grown fast to the third; lower pharyngeal large, thick, triangular, with concave surface. Vertebræ about 50.

Herbivorous fishes of the warm seas; mostly shore species; a few pelagic, a few confined to fresh water. They feed chiefly on green algæ, and, like the related forms, swim at the surface, occasionally

leaping into the air. Size rather small, rarely exceeding a foot in length. The species are closely related to the flying fishes, and the two families apparently closely intergrade.

a. Lower jaw acute, longer than upper, or more or less produced; teeth small; species oviparous, the anal fin in the male not modified, the caudal fin unequally lunate.
b. Lower jaw produced in a long, pointed beak, usually longer than rest of head. Body moderately compressed; pectorals moderate; shore fishes.
c. Air bladder simple; sides of body more or less convex; ventrals inserted anteriorly, far in advance of dorsal........................*Hyporhamphus*, 2.

2. HYPORHAMPHUS Gill.

Hyporhamphus Gill, Proc. Ac. Nat. Sci. Phila., 1859, p. 131, (*tricuspidatus*=*unifasciatus*).

Body elongate, moderately compressed, the sides of body not vertical, but more or less convex; the dorsal outline parallel with that of the belly. Upper jaw short; lower jaw prolonged into a slender beak, bordered with membrane; this beak shorter in the young; premaxillaries forming a triangular plate, the teeth of which fit against the toothed portion of the mandible; maxillaries joined to premaxillaries. Teeth feeble, mostly tricuspid. Gill rakers rather long. Head covered above with large, shield-like scales. Scales large, deciduous. No finlets; caudal fin more or less forked, the lower lobe the longer; dorsal and anal similar, opposite each other, not modified in the males; last ray of dorsal usually short; ventrals small, inserted well forward, nearly midway between opercle and base of caudal. Oviparous. Air bladder large, simple, not cellular. Young with the lower jaw short. Sides usually with a distinct silvery band, as in *Atherina*. Species numerous in all warm seas, going in large schools, but usually remaining near shore, feeding chiefly on green algæ. Size comparatively small.

(ὑπό, below; ῥάμφος, beak.)

a. Front of anal not behind front of dorsal.
b. Anal and dorsal opposite each other; scales 106......................*sajori*, 5.
bb. Anal slightly in advance of dorsal; scales 70........................*kurumeus*, 6.
aa. Front of anal under middle of dorsal..........................*japonicus*, 7.

5. HYPORHAMPHUS SAJORI (Schlegel).

SAYORI.

Hemiramphus sajori Schlegel, Fauna Japonica, Poiss., 1846, p. 246, pl. cx, fig. 2; Nagasaki.—Bleeker, Verh. Bat. Gen., 1853, XXV; Japan, p. 116; Nagasaki.—Günther, Cat. Fish., VI, 1866, p. 265 (copied).—Steindachner and Döderlein, Fische Japans, IV, 1887, p. 38; Tokyo.—Ishikawa, Prel. Cat., 1897, p. 18; Tokyo, Toshima.

Hemiramphus occipitalis Gill, Proc. Ac. Nat. Sci. Phila., 1859, p. 148; young specimen from Shimoda.

Head from tip of upper jaw $4\frac{3}{4}$ in length; depth 12. Dorsal 16; anal 17; scales 106. Eye 2 in postorbital part of head.

Body not much compressed. Mandible not extremely elongate, its length from posterior angle of mouth equal to distance from same point to base of pectoral. Upper jaw a little longer than wide. Gill rakers slender, the longest half the diameter of eye, 8+21 in number.

Top of head and tip of upper jaw scaled to tip, the scales more imbricated than in *H. kurumeus*. Sides of mandible with scales; 74 scales in a median row on back between dorsal fin and occiput.

Dorsal and anal opposite to each other and of about the same length; base of dorsal equal to distance from tip of upper jaw to posterior of eye. Ventrals inserted midway between anterior margin of eye and tips of median caudal rays. Length of pectoral equals postorbital part of head and half eye. Lower caudal lobe the longer, as long as base of dorsal. The middle rays not quite twice the diameter of eye.

Color in spirits: Brownish above, silvery below lateral stripe; scale pouches outlined with dark-brown dots on back. Sides of head silvery; mandible black; top of head and upper jaw dusky or black; lateral stripe distinct, widest under front of dorsal, outlined above by a dusky stripe. Dorsal and caudal dusky, other fins colorless.

Here described from a specimen 25 cm. in entire length from Aomori.

The young of this species agree very well with Dr. Gill's description of *H. occipitalis* (which was taken from a specimen 4 inches in length) except that his specimen is alleged to have fewer anal rays and 2 or 3 fewer dorsal rays. Owing to the small size of his type, a mistake of this sort might easily be made. No species other than *H. sajori* has been recognized along the coast of Hondo. Specimens were collected in salt water at Nagasaki, Matsushima, Aomori, Same, Tokyo, Misaki, Wakanoura, Kobe, and Hakata. It is one of the commonest fishes of Japan, much used for food.

(*sayori*, the vernacular name.)

6. HYPORHAMPHUS KURUMEUS Jordan and Starks, new species.

Head from tip of upper jaw 5 in length; depth 10 to 11. Dorsal 15 or 16; anal 17 or 18; scales 70.

Body not much compressed, the depth appearing greatest just behind opercles. Lower jaw from tip of upper half length of head; upper jaw slightly longer than wide. Teeth in upper jaw in a straight band at extreme sides, becoming broader anteriorly; those in lower jaw in a band narrower than the band at front of upper jaw and becoming narrower anteriorly. Eye equal to interorbital space, and contained twice in postorbital part of head. Gill rakers slender, scarcely as long as pupil, 7+19 in number.

Scales on top of head extending to snout. They are scarcely imbricated, circular, and with concentric striations, which form complete circles; similar scales on sides of mandible; from 47 to 50 scales in a median series on back between occiput and front of dorsal.

Pectoral rather slender and pointed, its length equal to eye and postorbital part of head. Anal beginning slightly in advance of dorsal. Base of dorsal equal to head from anterior edge of preorbital. The tip of the last dorsal ray when declined reaches to within a distance equal to the diameter of the eye of the base of the upper caudal rays. The ventrals are inserted midway between the base of the caudal rays and a point at the middle of opercle. The lower lobe of the caudal is the longer; its length equals that of pectoral, and is two-thirds the diameter of the eye longer than the upper lobe. The caudal is not deeply forked, the middle rays equal the postorbital part of the head.

No silvery pigment remains upon the body except along the lateral stripe, which is very conspicuous, much broader posteriorly than anteriorly, and bordered above by a dark line; back sparsely covered with small dark brown points, which sometimes outline the scale pouches; they usually arrange themselves in three lines medially along the back;

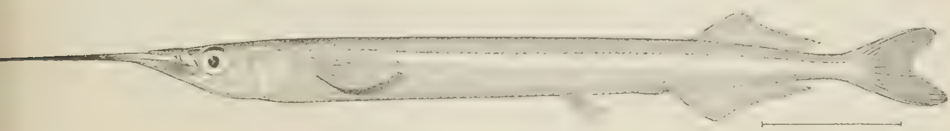


FIG. 1.—HYPORHAMPHUS KURUMEUS.

opercles bright silvery; top of head and upper jaw dusky, with black dots; a black blotch on mandible below maxillary; process of mandible jet black; fins all colorless except caudal, which is dusky.

This species differs from *H. intermedius* (as described by Dr. Günther) in having a slightly shorter anal, smaller eye, more anterior ventral, and pectoral not "blackish."

This is a fresh-water species. Numerous specimens were taken in the Chikugo River at Kurume, in the province of Chikugo, island of Kiusiu.

The type is 175 mm. in entire length and bears the number 7126 Ichthylogical collections, Leland Stanford Junior University Zoological Museum.

Dr. Ishikawa further records *Hyporhamphus dussumieri* (Cuvier and Valenciennes) from the Riukiu Islands. In this species of the Indian Ocean the dorsal and anal are nearly scaleless and the ventral midway between the head and the base of caudal. Sides with a silvery band. D. 15; A. 14. Scales 52.

7. HYPORHAMPHUS JAPONICUS (Brevoort.)

Hemirhamphus japonicus BREVOORT, Perry's Exp. Japan, 1856, p. 280; Loo Choo (Riukiu) known from a figure only.

Tip of lower jaw to edge of opercles 3 times in length from same point to center of margin of caudal. Tip of upper jaw to edge of opercles half of last, or 6 times in total length. Height of head or

body 9 times, and origin of dorsal to center of caudal a little less than one-fifth of length. Origin of anal to center of caudal 7 times and to origin of ventrals $3\frac{3}{4}$ in total length. Lower lobe of caudal $6\frac{1}{4}$ times in same distance; upper lobe one-third shorter and much narrower. Eye $2\frac{1}{2}$ in depth. Head and beak strong and stout. Body of equal height as far as ventrals. Pectorals pointed and equal to height of body in length. Ventrals with emarginate border, first and last ray of equal length. Dorsal with first ray nearly as long as height of body, with emarginate border, and last rays quite short. Anal beginning under middle of dorsal, and resembling it in form, but smaller. Caudal so deeply forked that it appears separated into two distinct lobes. Lower lobe longest and broadest, both pointed. Scales large, appearing to resemble those of *Hyporhamphus commersonii.*

Color bluish, darkest on back, lighter below. A tinge of green on sides and upper lobe of caudal. A narrow strip of green on middle of sides reaching from pectoral to caudal, with a broader stripe of pale silvery blue, tinged with greenish, bordering it on each side. Lower jaw dark indigo blue toward the tips, lighter toward the head. Fins all pale bluish, caudal dark dusky blue. Scales on back appear to have darker on their margins. (Brevoort.)

This species has not been seen since the drawing was made from which Brevoort compiled his description. His type was from Nafa, in the Riukiu Islands (Okinawa). The species is very doubtful and may not differ from *H. sajori.*

Family III. SCOMBRESOCIDÆ.

Body elongate, compressed, covered with small, thin, deciduous scales, the general aspect being that of a mackerel. Both jaws in the adult more or less prolonged, forming a slender beak, the upper jaw always the longer; teeth very feeble, pointed; maxillaries joined fast to premaxillaries, pectoral and ventrals small; dorsal and anal low, similar to each other, each with 4 to 6 detached finlets, as in the *Scombridæ;* gill rakers numerous, long and slender. Pharyngeal bones essentially as in *Exocœtus;* fourth upper pharyngeal on each side wanting or fused with the third; third pharyngeal greatly enlarged, separate from its fellow, covered with tricuspid teeth; second with simple teeth; first toothless; lower pharyngeals united, forming a triangular bone with concave surface, covered with tricuspid teeth; into the hollow of this bone the upper pharyngeals fit. Species few; pelagic fishes, swimming close to the surface in large schools in temperate regions. They bear strong analogical resemblances to the mackerels in form, color, and habits, as well as in the dorsal and anal finlets. The significance of this resemblance is unknown.

a. Jaws produced in a short beak, about half-length of rest of head.... *Cololabis*, 3.

3. COLOLABIS Gill.

Cololabis GILL, Proc. U. S. Nat. Mus., XVIII, 1895, p. 176.—JORDAN and EVERMAN, Fishes North and Middle Amer., I, 1896, p. 726 (*brevirostris.*)

This genus is close to *Scombresox*, differing chiefly in the very short beak, the upper jaw, even in the adult, not being at all produced, and the lower jaw having only a short flexible tip. This genus represents the immature state of *Scombresox*.

(κολός, defective, curtailed; λαβίς, forceps.)

8. COLOLABIS SAIRA (Brevoort).

SAMMA.

Scombresox saira BREVOORT, Perry's Exp. to Japan, 1856, p. 281, pl. VII, fig. 4 (on a drawing).—ISHIKAWA, Prel. Cat., 1897, p. 18; Tokyo.

Scombresox saurus NYSTROM, Svensk. Vet. Akad. Handl., 1887, p. 46; Nagasaki, not of Walbaum.

Head, including tip of lower jaw, $4\frac{1}{2}$ in length; depth $7\frac{3}{4}$. Dorsal 10 to 12—V or VI (rarely VI); anal 12 to 14—VI or VII; scales 120.

Body elongate and much compressed, the width of head $1\frac{1}{2}$ the diameter of eye. Eye placed exactly between tip of mandible and edge of opercle, its diameter contained $2\frac{1}{4}$ in snout. Teeth extremely small, in a single scattered row on edge of jaws, sometimes not evident. Maxillary produced to a sharp point; as viewed from above it is as long as broad. Mandible projecting to a short point, which enters upper profile when mouth is closed. Interorbital width equals diameter of eye, opercle and subopercle together forming a broad plate continuous on lower outline with that of the rest of head and ending behind in a blunt right angle. Gill rakers slender and numerous, as long as three-fifths the diameter of eye, 27 on lower part of arch. Gill slit not open above upper ray of pectoral. Top of head to tip of upper jaw with scales. One or two specimens show slight traces of large scales on opercles, cheeks, mandible, and preorbital. Usually, however, no trace remains, and in none of our numerous specimens are there any scales remaining in this region. Scales on body caducous, about 90 in a median row between occiput and dorsal. Pectoral short and broad, the lower rays growing rapidly shorter, its length twice diameter of eye. Ventrals inserted midway between base of caudal and middle of eye. Front of anal half the diameter of eye in advance of dorsal. Dorsal and anal finlets connected to body by an extremely thin delicate membrane which is usually broken and not evident, but through our large series it has been found with each finlet but the last.

Color in spirits abruptly silvery on lower half of body, above which is usually a bluish silvery lateral band nearly as wide as eye. Back

above lateral band abruptly slaty blue. Top of head to tip of upper jaw dark. Dorsal, caudal, and inner surface of pectoral dusky. Base of pectoral dusky. Other fins colorless.

Here described from numerous specimens 15 to 18 cm. in entire length, from Awa, obtained from Yonekichi Koneyama, a local naturalist.

Other specimens are from Otaru, Aomori, and Hakodate, the longest 29 cm. in length. It is locally known as Samma. The name *Saira* (*Sayori*) is used only for *Hyporhamphus*. Although not recognized by any author except Ishikawa since Brevoort, the species is common, running in large schools in sheltered bays from Tokyo northward. Nystrom's *Scombresox saurus* with shorter snout ("mendre ut dragen nos") is evidently *Cololabis saira*. The figure of Brevoort does not show correctly the number of finlets, which are 6 or 7, as in *Scombresox saurus*. The rare Californian species, *Cololabis brevirostris*, is close to *Cololabis saira*.

(*Saira* [*Sayori*], Japanese name of *Hyporhamphus*.)

Family IV. EXOCŒTIDÆ.

FLYING-FISHES.

Body oblong or elongate, covered with cycloid scales, which are rather deciduous. Lateral line running very low, along the sides of the belly. Head more or less scaly, with vertical sides. Mouth moderate, terminal, the jaws not prolonged into a long beak. Premaxillaries not protractile, hinged at base mesially; margin of the upper jaw chiefly formed by the premaxillaries; the short maxillaries entering the lateral margin; maxillary free from the premaxillary, its edge slipping under the front of the preorbital. Dentition various, the teeth small and weak. Dorsal fin without spines, inserted on the posterior part of the body, opposite the anal and more or less similar to it; ventrals abdominal, of several soft rays, inserted posteriorly; pectoral fin inserted high, used as an organ of flight; shoulder girdle and pectoral muscles very strong; caudal fin forked, the lower lobe the longer. No finlets. Vent close in front of anal. Nostrils large, double, near the eye. Lower pharyngeals enlarged and fully united, forming a large, transversely concave plate, covered with large, close-set, blunt, tricuspid teeth; third upper pharyngeal greatly enlarged, not united with its fellow, both covered with large, blunt, tricuspid teeth; fourth superior pharyngeal wanting in the adult (probably coossified with the third; vertebræ without zygapophyses. Gill membranes not united, free from the isthmus. Pseudobranchiæ hidden, glandular. Gill rakers various. Gills 4, a slit behind the fourth. Air bladder very large, not cellular, so far as known, and extending far backward among the hæmapophyses of the caudal vertebræ. Vertebræ

about 50. Intestinal canal simple, without cœca. Carnivorous or herbivorous. Abounding in all warm seas, mostly pelagic, swimming near the surface, and skipping or sailing through the air, sometimes for considerable distances.

a. Roof of mouth nearly toothless; pectoral and ventral fins very long, both used as organs of flight.
b. Anal fin long, its base about equal to that of dorsal, its rays 11 or 12. *Exonautes*, 4.
bb. Anal fin short, notably shorter than dorsal, its rays 9 or 10...... *Cypsilurus*, 5.

4. EXONAUTES Jordan and Evermann.

Exonautes JORDAN and EVERMANN, Check List Fishes N. Amer., 1896, p. 322, (*exsiliens.*)

This genus includes those flying fishes having both pectoral and ventral elongate and the anal fin about as long as the dorsal fin, of 11 or 12 rays.

Species numerous, smaller in size than those of *Cypselurus*, although larger than those of *Exocœtus* proper.

(ἔξο, out of; ναύτης, swimmer.)

9. EXONAUTES BRACHYCEPHALUS (Günther).

Exocœtus brachycephalus GÜNTHER, Cat. Fish., VI, 1866, p. 297; China.—LÜTKEN, Vid. Med. Nat. Foren, 1876, pp. 110, 405.

Head, $4\frac{1}{2}$ in length; depth, $6\frac{1}{2}$. Dorsal, 11; anal, 12; scales, 49. Eye, $3\frac{1}{6}$ in head.

Snout short, $1\frac{1}{3}$ in diameter of eye; interorbital space broad, its width a little greater than diameter of eye; supraorbital region pro-

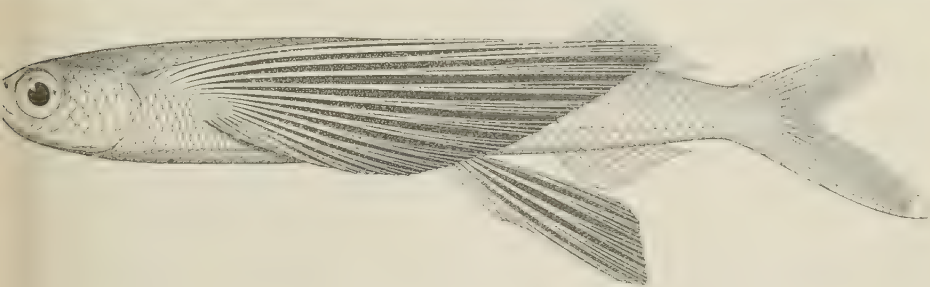


FIG. 2.—EXONAUTES BRACHYCEPHALUS.

truding on each side, making interorbital concave; maxillary reaching to just below anterior margin of eye. Thirty-four scales on a median line of back before dorsal. Lateral line forming a more than usually conspicuous ridge along lower sides of belly. Pectoral reaching to tip of declined anal ray; its first ray contained $2\frac{1}{4}$ times in entire fin and exceeding the head in length by a distance equal to the diameter of the eye. The outer half of the divided second ray fails to reach the tip of the third or largest ray by a distance equal to eye and snout; the inner half extends nearly to the tip of the third. Ventrals inserted

midway between the base of the caudal and the posterior margin of the eye: they reach slightly past the tips of the pectorals. The inner part of the second ray and the outer part of the third protrude beyond the tips of the other rays and form a sharp angle. The outer rays of the ventrals are not graduated. The first or outer ray is scarcely over a third as long as the longest part of the second.

Color in spirits a clear light brown above, silvery below. The membrane of the pectoral is dark brownish, without spots or markings. The rays on the outer side are silvery, making the fin appear silvery when closed. Ventrals brown like pectorals, with the inner and outer ray very light. Anal colorless and dorsal colorless, except for a small dark brown spot at tips of fifth and sixth rays. Caudal dusky.

Here described from a small specimen from Misaki, presented by the Imperial University of Tokyo. It is 13 cm. in length. It is probably rare in Japan, drifting northward in the warm current, or Kuro Shiwo. It was originally described from China. It has been identified, probably incorrectly, with the European species, *Exonautes rondeleti*.

(βραχύς, short; κεφαλή, head.)

5. CYPSILURUS Swainson.

Cypsilurus Swainson, Classification Fishes, etc., II, 1839, p. 296 (*nuttalli*, based on young with barbels).

Body elongate, broad above, somewhat compressed. Head short, blunt, narrowed below. Mouth small. Jaws very short, about equal. Chin without barbel in the adult, often with one or two long fragile barbels in the young. Maxillaries not joined to the premaxillaries. Teeth very feeble or wanting. Eyes large. Gill-rakers moderate. Scales large, deciduous. No finlets. Dorsal fin short, opposite anal, which is shorter than dorsal, of nine or ten rays. Caudal widely forked, the lower lobe the longer. Pectoral fins very long, reaching past the beginning of the anal, and serving as organs of flight, their great size enabling the fish to sustain themselves in the air for some time. Ventral fins large, posteriorly inserted, also used as organs of flight. Air bladder very large. No pyloric cæca. Species numerous in all warm seas, living mostly in the open water and swimming in great schools. The species are largely cosmopolitan and are the largest of the flying fishes.

(κύψελος, swallow; οὐρά, tail.)

a. Second pectoral ray divided.
  b. Ventrals pale or slightly dusky.
    c. Pectoral fins unspotted, reaching nearly to end of dorsal: D. 13. A. 9; scales, 52 .... *agoo*, 10.
    cc. Pectoral fins spotted with black; anal pale; scales, 42 ...... *pœcilopterus*, 11.
  bb. Ventrals mostly jet black; anal black posteriorly; fins all dark: D. 12. A. 9. *hirundo*, 12.

10. CYPSILURUS AGOO (Schlegel).

TOBI-NO-UWO (FISH OF FLIGHT:) TOBISUWO (FLYING-FISH): AGU.

Exocœtus agoo SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 247; Nagasaki, from a drawing.—ISHIKAWA, Prel. Cat., 1897, p. 18; Tokyo.

Cypselurus agoo JORDAN and SNYDER, Check List Fishes of Japan, 1901, p. 60; Yokohama.

Exocœtus döderleini STEINDACHNER, Fische Japans, IV, 1887, p. 38; Tokyo.

Cypselurus döderleini JORDAN and SNYDER, Check List, 1901, p. 60; Yokohama.

Head, $4\frac{1}{2}$ in length; depth, $5\frac{3}{4}$ to $6\frac{1}{2}$. Dorsal, 13 or 14; anal, 8 or 9; scales, 52; eye, $3\frac{1}{4}$ to $3\frac{1}{2}$ in head.

The depth of head and body is very variable; in some specimens the opercle is broadly rounded; in others it slants upward and backward more obliquely and has a slight flap. Between these extremes there are all intermediate conditions.

The pectoral reaches in the shortest examples nearly or quite to the base of the last dorsal ray; in the longest to the tips of the last declined dorsal ray. The simple upper ray is contained about $1\frac{3}{4}$ times in the length of the entire fin. The second ray is branched, its

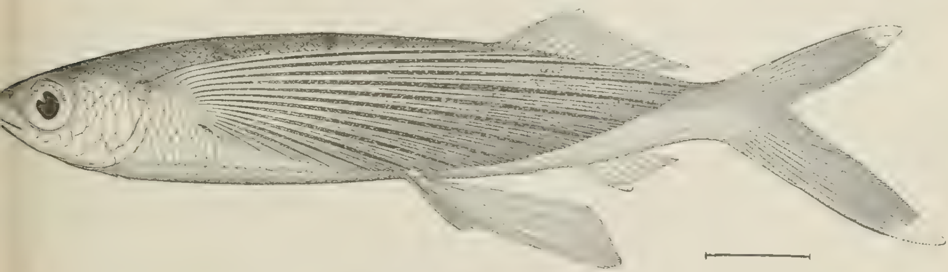


FIG. 3.—CYPSILURUS AGOO.

lower branch the longer, and reaches to within from 1 to 2 times the diameter of the eye to the tip of the third or longest ray. The succeeding rays rapidly and uniformly diminish in length to the ninth ray, and thence more rapidly to the last.

The ventrals reach from slightly beyond the middle to the end of the anal base. The base of the dorsal is contained from $1\frac{1}{5}$ to $1\frac{1}{4}$ in head; that of the anal, $2\frac{1}{2}$ to $2\frac{3}{5}$.

Color in spirits slaty brown on back, shading to silvery on lower parts of head and body; when scales are lost, as in most of our specimens, the color is bluer and the edges of the scale pouches are conspicuously dark. The maxillary is dusky; a dark band is on eye around and above upper part of iris. The ventrals are white on lower surface, on upper either white or slightly dusky along the outer rays; nearly always the base of the first ray is dusky. In the closed pectoral the upper rays to their tips appear lighter than the median rays, which grow gradually darker to black toward their tips. The membrane is bluish black, fading out below and colorless between lower rays. Color in life metallic bluish above.

The above description is taken from specimens 10 to 12 inches long from Nagasaki.

Numerous specimens were collected at Tsuruga, Nagasaki, Tokyo, Myiako (mouth of Sendai), Hiroshima, Hakata, Onomichi, and Aomori.

It is the common flying fish or Tobis-Uwo of Japan, abundant all along the coast in the summer. It is subject to a number of variations, but all specimens examined by us seem to belong to one species. *Exocœtus döderleini* is evidently identical with *Cypsilurus agoo.*

(*agu*, a vernacular name, now rarely used.)

11. CYPSILURUS PŒCILOPTERUS (Cuvier and Valenciennes).

Exocœtus pœcilopterus Cuvier and Valenciennes, Hist. Poiss., XIX, p. 112, pl. dcxi; New Britain.—Günther, Cat. Fish., VI, 1866, p. 291; Formosa.
Exocœtus, sp. No. 309, Ishikawa, Prel. Cat., 1897, p. 18; Hakodate.

A specimen in the Imperial Museum at Tokyo is probably referable to the above species. The following notes were taken on this specimen:

Scales 42, 24 before dorsal; anal short; head flattish above; body rather plump; pectoral reaching to middle of dorsal, its second ray divided; dorsal low; ventrals reaching past front of anal.

Color: Ventrals dusky behind, perhaps faded; dorsal unspotted; pectorals profusely and coarsely spotted with black, the spots unequal. According to Günther the dorsal has 12 or 13 rays, the anal 9, the distance from first dorsal ray to first of caudal being much greater than length of head.

Described from a stuffed specimen, 10 inches in length, taken at Hakodate. It is questionable whether this species is really identical with *C. pœcilopterus*, but no other described species agrees as well.

(*ποικιλός*, variegated; *πτερόν*, fin.)

12. CYPSILURUS HIRUNDO (Steindachner.)

Exocœtus hirundo Steindachner, Ichthyol. Mittheil., VIII, 1866, p. 482, pl. iv, fig. 2; Hongkong.

Head 4[illegible] in length; depth 6[illegible]. Dorsal 12; anal 9; scales about 53.

Body not compressed, about as wide as deep, the head short, widest at a level with upper edge of pupil; its width equal to distance from edge of opercle to middle of eye. Eye two-fifths longer than snout, contained 1[illegible] times in postorbital part of head. Lower jaw projecting, the tip injured in our specimen and the barbels missing. The interorbital space is wide and shallowly concave, its width a little greater than the diameter of the eye. Snout short and broad at the anterior margin of the eyes; its width is three-fifths of its length.

The pectoral reaches to under the seventh or eighth dorsal ray. Its upper ray is undivided and is contained 2¾ times in the length of head

and body. Its second ray is divided, the under ray the longer, reaching to within a diameter of the eye of the tip of the third or longest ray. The ventrals reach to the base of the lower caudal rays. Their base is midway between their tips and the edge of the opercle; three or four of its outer rays grow gradually shorter; the outer one is twice the diameter of the eye in length.

Color in spirits light brown on back, abruptly silvery on head and body below the level of middle of eye. The maxillary is dusky and the suborbital and opercular regions are dusky with points of brown over the silver. The pectoral is jet black, changing to white on the lower rays. The ventrals are colored like the pectoral and with lighter inner rays. The dorsal is dusky toward the ends of the rays. The posterior fourth of the anal is abruptly black. The caudal has two dusky spots, which appear in Dr. Steindachner's plate of this species as the interspaces between two white spots. The caudal peduncle is dusky above.

This description is taken from a specimen 10 cm. in length from Wakanoura.

A small specimen, 35 mm. in length, differs in having the pectoral reaching only to below the third dorsal ray. At the symphysis is a wide, flat, triangular barbel, which is very slightly trifid at its lower margin.

This species is apparently identical with *Exocœtus hirundo* described and figured from Hongkong. It is not yet recorded from elsewhere.

(*hirundo*, swallow.)

SUMMARY.

Suborder SYNENTOGNATHI.

Family I. Belonidæ.

1. *Tylosurus* Cocco.

1. *schismatorhynchus* (Bleeker); Nagasaki, Wakanoura.
2. *giganteus* (Schlegel); Nagasaki, Wakanoura.
3. *coromandelicus* (Van Hasselt); Tsuruga, Yokohama.
4. *anastomella* (Cuvier and Valenciennes); Yokohama, Tokyo, Matsushima Bay, Hakodate.

Family II. Hemiramphidæ.

2. *Hyporhamphus* Gill.

5. *sajori* (Schlegel); Aomori, Matsushima, Tokyo, Misaki, Wakanoura, Kobe, Hakata, Nagasaki.
6. *kurumeus* Jordan and Starks; Chikugo River at Kurume.
7. *japonicus* (Brevoort).

Family III. Scombresocidæ.

3. *Cololabis* Gill.

8. *saira* (Brevoort); Awa, Aomori, Hakodate, Otaru.

Family IV. Exocœtidæ.

4. *Exonautes* Jordan and Evermann.

9. *brachycephalus* (Günther); Misaki.

5. *Cypsilurus* Swainson.

10. *agoo* (Schlegel); Aomori, Tokyo, Miyako in Rikuzehu, Tsuruga, Nagasaki, Hiroshima, Onomichi, Hakata.
11. *pœcilopterus* (Cuvier and Valenciennes); Hakodate.
12. *hirundo* (Steindachner); Wakanoura.

NOTES ON THE OSTEOLOGY AND RELATIONSHIP OF THE FOSSIL BIRDS OF THE GENERA HESPERORNIS HARGERIA BAPTORNIS AND DIATRYMA.

By Frederic A. Lucas,
Acting Curator, Section of Vertebrate Fossils.

Our knowledge of the few Cretaceous birds that have been discovered in North America is very imperfect in spite of Professor Marsh's memoir on the Odontonithes; their origin and many points of their structure are still unknown and their relationship uncertain. By the kindness of Professor Williston, I am able to add a little to our knowledge of the structure of *Hesperornis gracilis* and *Baptornis advenus*, while the acquisition of a specimen of *Hesperornis regalis*, by the United States National Museum, enables me to add a few details concerning that species.

CRANIUM OF HESPERORNIS GRACILIS.

The example of *Hesperornis gracilis* belongs to the University of Kansas, and comprises a large portion of the skeleton, including the skull. Unfortunately the neck was doubled backward, so that the skull lay against the pelvis, while portions of dorsal and sternal ribs had become crushed into and intimately associated with the cranium, so that it was impossible to make out the shape of the palatal bones, provided even they were present. This was particularly unfortunate, as information as to the character of the palate of the toothed birds is greatly to be desired. Theoretically, the arrangement of the bones of the palate should be somewhat reptilian, or, if the struthious birds are survivals, the palate of such a bird as Hesperornis should present some dromæognathous characters. But, as was pointed out by D'Arcy Thompson, the skull of *Hesperornis regalis*, as described and figured by Marsh, differs very considerably from that of an ostrich, and the present specimen emphasizes or adds to the differences already noted. The presence of depressions for supraorbital glands and the size of the sagittal and lambdoidal crests neither denotes affinities with grebes and loons nor separation from struthious forms, since these characters are associated with aquatic and predatory habits and have no morphological value.

Owing to the crushed condition of the smaller bones and presence of numerous fragments of other parts associated with the cranium, it has proved impossible to ascertain the exact arrangement of the palatal bones, although it is apparent that this was quite different from that found among existing birds, either the Dromæognathæ or Eurhipiduræ. While the head of the quadrate is undivided, the body of the

FIG. 1.—INTERNAL AND EXTERNAL ASPECT OF LEFT QUADRATE OF *Hesperornis gracilis*, × 1½.

bone is slender and not overlapped and held in by a descending process of the squamosal; and these are important characters, especially the latter. The short, heavy quadrate of the Dromæognathæ, locked in by the squamosal so as to be practically immovable, is a decidedly reptilian feature, eminently characteristic of the group and widely at variance with the conditions found in Hesperornis. The ascending or lachrymal process of *Hesperornis gracilis* is very long, quite unlike that of *Hesperornis regalis* as described and figured by Professor Marsh.[a] Just at its junction with the body of the quadrate there is a very evident articulation for the pteryoid.

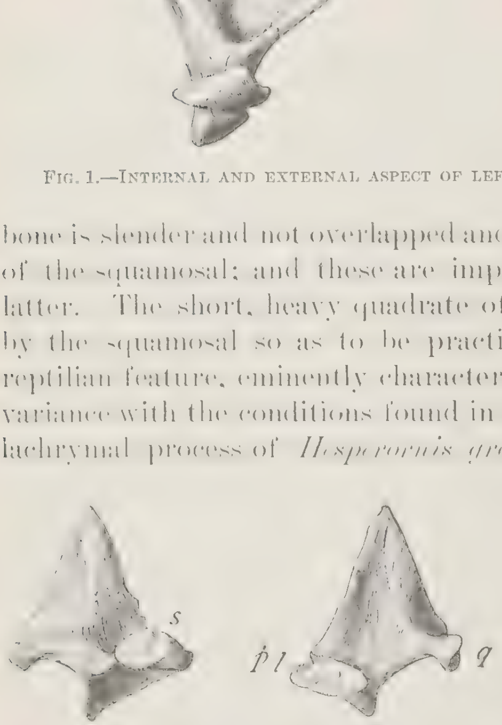


FIG. 2.—SUPERIOR AND INFERIOR VIEWS OF RIGHT PTERYGOID OF *Hesperornis gracilis*. × 1½. *pl*, ARTICULATION OF PALATINE; *q*, ARTICULATION OF QUADRATE; *s*, ARTICULATION OF SPHENOID.

The pterygoid has much the same general shape as that of *Hesperornis regalis*, but differs from it slightly in details. It is a small, flat bone, roughly rhomboidal in outline and with three articular surfaces, for the quadrate, basisphenoid, and palatine, as indicated on the accompanying figures. The most important of these is an elliptical facet at right angles to the body of the bone, for this is considered to be the facet for articulation with the basisphenoid, and this is connected with the question of the presence or absence of basipterygoid processes. The entire under surface of the skull is considerably cracked and com-

[a] Dr. Beecher, who has kindly examined the Yale specimen, the original of Professor Marsh's figure, writes me that the process was naturally short and not the result of any breakage of the superior margin.

pressed, and at first sight there appeared to be no surface for articulation with the facet just mentioned. Close inspection, however, showed on the left side an apparent articular face of the proper size to receive the flat, articular portion of the pterygoid, though not projecting above the general level of the sphenoid. The basisphenoid of Hesperornis has thus absolutely nothing of the cruciform shape, due to the large, projecting basipterygoid processes, so eminently characteristic of the Dromæognathæ.

Among the Dinornithidæ, Emeus, and Meionornis have comparatively short basipterygoids, but even in these birds the processes project markedly above the level of the basisphenoid, while in Hesperornis this bone was in appearance not unlike the corresponding region of a loon, or penguin. The third articulation on the pterygoid would be for the palatine, but it is not easy to imagine the shape of a palatine that would fit such a surface and accord with the rest of the bones. The bone considered as a palatine by Professor Marsh is long and slender, with an articulation indicated on one side at about one-third the length of the bone; a somewhat similar, though imperfect, bone is present in the specimen of *Hesperornis regalis* belonging to the United States National Museum, but neither of these seems adjustable to the present pterygoid. In the present instance the pterygoid lay immediately over the left quadrate, but in spite of this intimate association, it appears probable that it is from the right side. With its point directed backward the supposed palatine articulation would be brought on the anterior side and in the proper position for union with the palatine and vomer. Such a disposition would give an arrangement of the bones of the palate somewhat analogous to that found in the Cassowary. The bone heretofore supposed to be a palatine may, perhaps, be the vomer, although it is difficult to account for the long portion back of the articulation. The vomer is said to have been double, and judging by the freedom of most of the bones of the cranium this may well have been the case. The bone figured as vomer in Odontornithes appears rather small for that of so large a bird as *Hesperornis regalis*. In the specimen of *Hesperornis gracilis* under consideration no bone, representing the vomer can be made out, nor are there any evidences of the presence of maxillo-palatines.

FIG. 3.—SUPPOSED LACHRYMAL OF *Hesperornis regalis*. SLIGHTLY REDUCED.

By one of the curious chances of fossilization, the fragile sphenoid rostrum has been preserved. It is long and slender, and its anterior portion underlies and unites with the mesethmoid precisely as it does in Urinator, there being a further similarity between this genus and Hesperornis in the large size of the interorbital vacuity. This is very

unlike the condition prevailing among the Dromaeognathæ, in which there is an extensive interorbital ossification.

Not only the component bones of the lower jaw, but the majority of those included in the cranium, appear to have been free from one another, with the exception of the premaxillæ. Whether this is due to the age of the individual or is a character common to the members of the genus Hesperornis can not now be decided; nor is it certain whether or not this freedom extended to the bones of the brain case, as the skull of *Hesperornis gracilis* has this portion still embedded in the matrix. In the Yale specimens the bones of the brain case appear to have been fused, although it is said that many of the other bones were free.

The example of *Hesperornis regalis* in the United States National Museum lacks the calvarium, but the bones of the jaw are quite free and so are two supposed to be the lachrymal and nasal, the former of which is here figured.

SHOULDER GIRDLE OF HESPERORNIS REGALIS.

Turning to the shoulder girdle, my own interpretation of this portion of the skeleton, based on material in the United States National Museum,[a] differs somewhat from that given by Professor Marsh in the memoir on the Odontornithes, the most important points being the shape of the distal end of the clavicle and the fact that the scapula and coracoid do not lie practically in the same plane, but the angle formed by them is little more than a right angle, which is different from what is found among struthious birds. That the scapula and coracoid are quite free from one another and possess all the articular faces found in corresponding bones of birds of flight is, of course, well known.

While the open angle between the scapula and coracoid of struthious birds was used by Huxley as one of the diagnostic characters of the Ratitæ, it has come to be quite generally regarded as merely due to degeneration, and practically a question of mechanics; as the coracoid shortened the proximal end of the scapula would be lowered and the coraco-scapular angle opened, until with a greatly abbreviated coracoid the scapula was almost in line with it, as in Casuarius. That the coraco-scapular angle in Hesperornis, a bird with a vestigial wing, is less open than in the Dromaeognathæ is perhaps still a question of mechanics. The struthious birds are heavy, short-bodied land birds, whereas Hesperornis was a long, lithe, proportionately slender-bodied diver, and unless the entire scapular arch was reduced the scapula could not be turned upward sufficiently to form an open angle with the coracoid. In this connection it may be noted that in Rhea, which has a rather long coracoid, the scapula is bent abruptly downward a short distance

[a] This specimen comes from the gray chalk, and the bones are but little crushed or distorted by pressure.

above its union with the coracoid in order to adapt itself to the curvature of the body. The suggestion may be made here that perhaps the ankylosis of scapula and coracoid which occurs among struthious birds may be of more value than is usually accorded it. This ankylosis occurs in these birds only, while the scapula and coracoid are in young birds suturally united as in dinosaurs.

The clavicle terminates distally in a small, slightly cup-shaped expansion which articulates with a small facet on the head of the coracoid. This is quite different from the description and figures in the Odontornithes where the clavicles are represented as pointed distally and articulating with the precoracoid process only, and I can only suggest that the specimens examined by Professor Marsh were slightly imperfect.

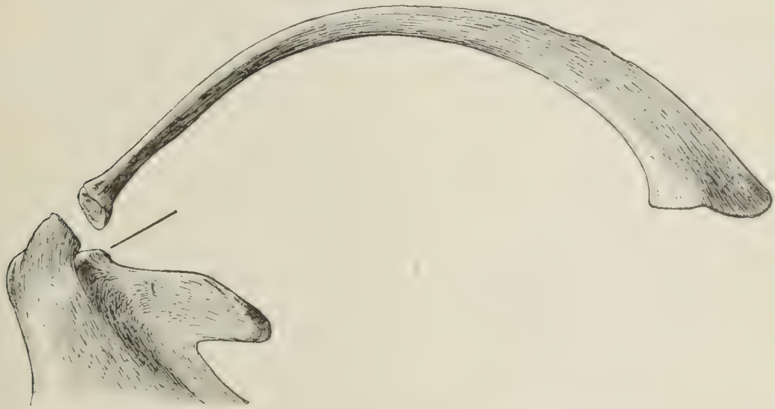


FIG. 4.—RIGHT CLAVICLE AND PART OF RIGHT CORACOID OF *Hesperornis regalis*, NATURAL SIZE. THE LINE SHOWS THE FACET FOR DISTAL END OF CLAVICLE.

The proximal ends of the clavicles appear to have been only slightly apposed, the major portion of the articulating surface being directed backward, probably for union with the anterior end of the sternum. We have in Harris's Cormorant a suggestion of how this condition of things may have been brought about, for in this flightless bird the keel of the sternum has aborted until its anterior end is even with the anterior end of the body of the sternum, and yet the keel still supports the clavicles as in other cormorants. This is an extremely good example of the retention of a morphological character while the entire pectoral girdle is undergoing degeneration and has ceased to be of use.

The relations of the bones of the pectoral arch in Hesperornis suggest that the conditions of the sternum in cormorants, where the keel is confined to the anterior portion, may represent a primitive type of sternum. Very similar conditions are found among the larger species of pterodactyls where the body of the sternum is smooth but a large anterior projection is present.

Following the description in Odontornithes Dr. Gadow[a] writes that in Hesperornis the clavicles articulate with the precoracoid process only. Such a union can not be brought about in the specimen in the United States National Museum while, as said above, there is a very evident union between clavicle and coracoid as shown in figure 4. The importance of this is evident, for if the clavicles ended in a point and articulated only with the precoracoid the shoulder girdle would have a strikingly reptilian facies; as it is, the conditions are not very unlike those found among existing birds. The retention of a complete clavicle in a degenerate shoulder girdle is, however, an important point, for in modern birds with degenerate wings it is the proximal part of the clavicles which disappears, leaving the heavier distal portion attached to the coracoids. The complete separation of the clavicles and the fact that the proximal portion is much the heaviest is also a generalized condition.

The scapular arch of Hesperornis may be thus defined: Coracoid and scapula free from one another, preserving all articular faces, and forming little more than a right angle with one another; clavicles complete, free, without scapular process, and articulating with the coracoid. In struthious birds, on the other hand, the scapula and coracoid are ankylosed in the adult, bear only the humeral articulation, and form a very open angle with one another; clavicles absent or vestigial and represented by distal ends only.

In skull and shoulder girdle Hesperornis presents an interesting combination of characters, on the one hand showing generalized features and on the other close resemblances to modern birds. Thus we have in the Cretaceous a bird with a palatal structure quite unlike that of any struthious bird and with a vestigial wing which yet preserves many features found in the limbs of birds possessed of the power of flight. Add to this that no struthious bird is, as yet known, from North America,[b] and we have an argument for those who believe that if birds did not have a diphylletic origin they at least divided into two very distinct branches early in their career.

In Animals of the Past attention was first called to the fact that the tarsi of Hesperornis were directed laterally outward almost at right angles to the body, instead of being directed downward as in other birds. This is brought about by the narrowness of the pelvis and straightness of the femur and by the outer and inner condyles of the femur being on the same level, instead of the outer being the lower of the two, as is usually the case among swimming birds. A similar arrangement, with similar results, is found in seals. From this position of the tarsi it would seem that the legs should naturally have been moved together, like a pair of oars, instead of alternately, although

[a] Newton's Dictionary of Birds, p. 858.

[b] See that part of this paper relating to Diatryma.

this may not have been the case. Having such a disposition of the legs combined with a total absence of external wings, Hesperornis must have been particularly awkward on land and probably came ashore as seldom as possible. Related to this peculiar position of the legs, it is suggested that the breeding habits must have been something like those of the grebe and loon and were such that at no time was the bird far from water. Even though Hesperornis was a marine bird, there is no reason why it could not have found plenty of suitable nesting places at once easy of access and yet beyond reach of the sea. That Hesperornis was a bird of cursorial habits before it took to the water is a supposition contradicted by every part of the skeleton. The elongate body, short femora, and great development of the outer

FIG. 5.—LATERAL, PALATAL, AND DORSAL VIEWS OF THE ANTERIOR PORTION OF THE CRANIUM OF A YOUNG CORMORANT, *Phalacrocorax urile*, SHOWING THE CHARACTER OF THE PALATE AND OF THE NARIAL OPENINGS. THE PALATINES HAVE BEEN REMOVED, ALL ENLARGED. *f*, FRONTAL; *l*, LACHRYMAL; *mxp*, MAXILLOPALATINES; *na*, NASAL; *pmx*, PREMAXILLARIES; *sr*, SPHENOID ROSTRUM.

toe are all opposed to such an idea, and were other evidence required it is supplied by our present knowledge of the position of the legs.

A few words may, perhaps, be said here regarding the relationships of Hesperornis. The alleged colymbine affinities have never been apparent to me, those portions of the skeleton which are thought to indicate kinship with grebes and loons appearing to me as similarities of structure, connected with similarity of habits. There are many points of resemblance between Hesperornis and the cormorants, as well as between Hesperornis and the grebes, such as the shape of the tibia, the presence of a large patella pierced for the ambiens and functioning as a cnemial process, and the arrangement of the bones of the pectoral arch. As for the cranium, all these birds—Hesperornis, grebes, and cormorants—are holorhinal and schizognathous. In the cormorants

the nostrils are intermediate in form between a typical holorhinal and schizorhinal nostril, being elongate and posteriorly somewhat angular, while they lie well in advance of the posterior termination of the premaxillaries. That Hesperornis was schizognathous is, of course, uncertain. The figures accompanying this show the nostril and palate of a young nestling of *Phalacrocorax urile*, and similar conditions prevail in the young of *P. dilopus*. The desmognathism of the cormorants is clearly a secondary condition and is not brought about until some time after hatching. The closing of the nostril does not take place until very much later, or apparently just before the young takes to the water. As previously noted by Mr. Pycraft, a trace of the nostril remains in the shape of a minute orifice closed by horn. My own interpretation of the maxillo-palatines differs from that of Mr. Pycraft, a fact which I regret, as he is usually right; but, in the present instance, the maxillo-palatines are so clearly defined in the nestling that I have no choice in the matter. The collections of the United States National Museum include a large number of species of cormorants and a series of skulls representing individuals from the time of hatching up to shortly before the young take to the water, and it is upon this series that I have based my conclusions.

That Hesperornis should stand in the direct line of ascent of the grebes is, of course, quite out of the question, as it would imply the derivation of a modern bird of flight from a degenerate, flightless form. That the two may have had a common ancestor is an entirely different proposition, but if such be the case we must go far back in time to seek for this hypothetical form. And it must ever be borne in mind in dealing with birds that our knowledge of early forms is extremely slight, so that we have a very small foundation of facts for a very large edifice of theory, a pyramid resting on its apex, as it were. Our knowledge is indeed so limited that what we are pleased to term theory is really little better than speculation.

HARGERIA, new genus.

Hesperornis gracilis differs so much from its larger relative that it should be placed in a distinct genus, for which the name *Hargeria* is proposed in honor of Mr. Oscar Harger, who was one of Professor Marsh's assistants at the time of his investigations of the toothed birds, and, as noted in the preface to Odontornithes, rendered valuable aid in its preparation. The most important character is the size of the quadrate and length of the ascending process, and in birds this means much, as there is a remarkable constancy in the shape of this bone among related forms.

As contrasted with *Hesperornis* the genus *Hargeria* may be defined as follows: Quadrate with a large, upwardly directed lachrymal process; processes of nasals short; length of femur more than twice its greatest width across the head.

BAPTORNIS ADVENUS.

The skull of this bird is still unknown, so that we do not know positively whether or not it had teeth, although this is probably the case. Neither do we know the relationship between Baptornis and Hesperornis; both were flightless aquatic birds, but the structure of the limbs shows that at least they belong in separate families.

The body appears to have been stout, the neck long and slender, the individual vertebræ being much more elongate than in Hesperornis, approaching in this respect Plotus or Podiceps.

The vertebræ present, unfortunately, are not consecutive, a portion only of the cervicals being present, while some of the dorsals belong to the anterior portion of the series and others to the posterior part. The hypapophyses appear to have been developed, much as in Hesperornis, well forward in the dorsal region, in contrast to what occurs in modern water birds, such as penguins, auks, and loons, in which the hypapophyses begin immediately in advance of the sacrum and are longest about the middle of the series.

This would throw the center of effort farther forward in the old diving birds than in modern species, and may be due to the use of the muscles either while capturing fish or in moving about on land.

The synsacrum seems to have comprised ten vertebræ, but this is not certain, the first of which belongs to the dorsal series and bore a rib. The sacrum of Hesperornis contained fourteen vertebræ. Nothing of the pelvis is present save the anterior portion of an ilium, and this, although weathered, resembles the corresponding portion of the ilium of Hesperornis. The dorsal vertebræ were all free, and so were the ossa innominata in both Baptornis and Hesperornis, but this freedom is to be regarded as due to the aquatic habits of these birds and not as morphological characters. While the bones of aquatic animals are heavier than are those of land animals, ossification and union between contiguous parts takes place much more slowly, and in such strictly aquatic birds as the penguin and great auk the dorsal vertebræ and ossa innominata are similarly free.

The coracoid is rather wide and thin, much longer than that of Hesperornis, and apparently without a precoracoid process or perforation; an articulation is present for the reception of the clavicle, but this latter bone was not preserved.

Only the proximal portion of one scapula, the left, is present; this indicates a stout bone, and there is a suggestion that it may have expanded distally, as in penguins, but this is suggested, nothing more.

The humerus is short, round in section, and considerably curved, as in Apteryx. Although the proximal end is lacking, it seems to have been not far from 4 inches (100 mm.) long. The radius and ulna are extremely short, measuring but three-fourths inch (20 mm.) in length.

The extraordinary thing about them is that short as they are they are perfectly formed and possess the muscular insertions of much larger bones, while it is evident that the bones of the manus were also present. This is quite different from Hesperornis, in which the humerus is rather long and straight, and the bones of the forearm and manus absent; it carries to an extreme conditions found in the great auk, a bird in which the forearm is much reduced, though still functional. Baptornis thus presents the peculiarity of a forearm of diminutive size, whose bones are perfectly formed, bear the muscular impressions of much larger wing bones, and imply the presence of quill feathers, and not improbably the use of the wings in conjunction with the feet in aquatic locomotion. In other birds in which the wings have undergone extensive reduction, such as Rhea and Struthio, to say nothing of Apteryx, the radius and ulna lack the well-defined form and muscular ridges of Baptornis.

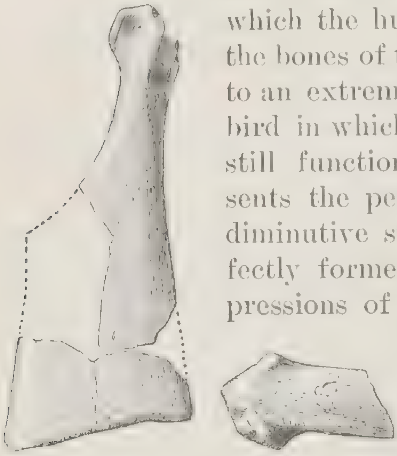


FIG. 6.—RIGHT CORACOID AND PORTION OF LEFT SCAPULA OF *Baptornis advenus*, NATURAL SIZE.

The femur, while short and stout, has nothing of the squareness shown by Hesperornis, but resembles rather that of a loon on a more massive scale. The greater trochanter is slightly raised above the level of the head of the femur, and the outer condyle extends below the level of the inner; the antitrochanter also appears to have looked slightly downward, so that the position of the leg in swimming was doubtless like that of existing waterfowl. This is the ordinary arrangement and would not be specially mentioned but for the fact that it is the reverse of these conditions, coupled with the character of the tibio-tarsal joint that causes the tarsus of Hesperornis to stand out almost at right angles to the body. The procnemial process of the tibia is higher than in Hesperornis, and the large patella appears to have articulated on one side of this, somewhat as in grebes, and not as in penguins and cormorants, where the patella functions as a cnemial process. The patella is large, of a modified trihedral form, and has a large perforation for the ambiens. The taxonomic value of such a perforation is lessened by the fact that among cormorants such a perforation is present in some species and absent in others, and while this may prove to be correlated with other characters the available material does not show this.

FIG. 7.—LEFT HUMERUS, RADIUS AND ULNA OF *Baptornis advenus*, NATURAL SIZE.

The tarsus is stout and somewhat compressed laterally; although weathered there appear to have been no tendinal grooves, much less any tendinal foramina, these last marking a degree of tarsal specialization vastly higher than was possessed by any Cretaceous bird. If it is permitted to borrow a little of the style of W. K. Parker it might be said that the early birds show a great deal of reptilian coarseness in their articulations, and lack the detail and sharpness of finish that came later and marks a higher degree of specialization. The lower end of the tarsus bears a faint imprint of the presence of the small first digit, but still as much as exists in some ducks. The phalangeal articulations are narrow, indicating compressed digits; this is also shown by the proximal fragment of a median digit. Compressed digits are now associated with lobate feet, and thus, so far as we know, the lobate foot preceded the webbed foot in point of time. Our knowledge of early birds is, however, so trivial that it is scarcely worth while to make any generalizations on this subject, the more that there is no reason why the two types of foot may not have been evolved

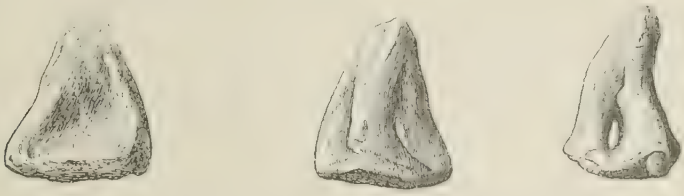


Fig. 8.—Right padella of *Baptornis advenus*, natural size.

independently of one another. The waders indeed suggest that the evolution was independent, as this group shows the beginning of such feet in such forms as the phalarope and avocet.

In the length of the coracoid and absence of a precoracoid process; in the existence of a complete though greatly reduced wing; the shortness of the sacrum; proportions of the leg bones and position when in use, Baptornis is very different from Hesperornis and more like existing birds. In the slender cervicals, arrangement of tibia and patella, and general structure of the leg Baptornis is more like a grebe than is the contemporary Hesperornis, and if, with the small amount of material available, it is deemed essential to establish any connection between groups of existing and fossil birds it is suggested that the ancestors of Baptornis are much more likely to have been also the progenitors of the Colymbine group than are those of Hesperornis.

It is certain, as said near the beginning of the notes on Baptornis, that this bird belongs in an entirely different family from Hesperornis, and if it is ever given to us to know more of the bird it may prove to belong in a separate order.

THE POSITION OF DIATRYMA.

Diatryma gigantea, from the Eocene of New Mexico, was placed with the struthious birds by Professor Cope, mainly, it would appear, on account of its size, since he points out some differences between the tarsus and that of the ostrich and emeu, and notes resemblances between the distal articulations and those of Gastornis. At the time Diatryma was described the great South American Stereornithes had not been discovered or Professor Cope would doubtless have instituted comparisons between them and Diatryma.

Unfortunately, the type and only specimen of Diatryma is a fragmentary tarsus, while the only material at hand representing the Stereornithes is an indifferent cast of Brontornis. Still there are sufficient resemblances between the two to warrant the suggestion that if material comes to light it will be found that the affinities of Diatryma are with the Stereornithes and not with the Dromæognathæ.

There is nothing more improbable in the North American origin of the Stereornithes than in the similar origin of the large edentates and llamas, both of which are subscribed to.

For the present there seems to be no evidence of the occurrence of any large dromaeognathous bird in North America, and the presence of the tinamous may be regarded as the northward extension of a southern fauna.

REDISCOVERY OF ONE OF HOLBROOK'S SALAMANDERS.

By Leonhard Stejneger.

Curator, Division of Reptiles and Batrachians.

Among the many synonyms usually cited under *Desmognathus fusca* (Rafinesque), *Salamandra quadrimaculata* of Holbrook[a] has been considered as belonging to this species without a shadow of a doubt. An even dozen, old and young, salamanders from North Carolina recently acquired by the United States National Museum seem to indicate that Holbrook's name belongs to a species well separated from *Desmognathus fusca* and in some respect approaching *D. nigra.* It may be formally recharacterized as follows:

DESMOGNATHUS QUADRIMACULATA (Holbrook).

1842. *Salamandra quadrimaculata* Holbrook, North Am. Herpet., 2 ed., V, p. 49, pl. xiii.

Type locality.—Georgia and the Carolinas.

Diagnosis.—Top and sides of head roughly granular; dentition essentially like *D. fusca;* head broad, its width less than 5 times in distance from tip of snout to groin; body short, distance between tip of digits of adpressed limbs about one-half the distance from tip of mandible to gular fold; 13 costal folds; chest and belly in adult more or less uniform slate color (in alcohol).

Specimens examined.—Cat. Nos. 30891–30902 U.S.N.M.; from a small stream flowing into the Catawba River, between Linville and Blowing Rock, North Carolina, collected September, 1902, by State entomologist Mr. Sherman.[b]

Remarks.—As already said this species approaches *D. nigra* in several features, for instance, in the shape of the head, but especially in its shortness of body and tail. Like this species it is also much larger than *D. fusca.* The number of costal folds is somewhat variable,

[a] North Am. Herpet., 2 ed., V, 1842, p. 49, pl. xiii.

[b] I have learned since from Mr. Sherman that these specimens were taken in a pool on the side of Grandfather Mountain, probably the same one whence came the types of Dr. J. Percy Moore's *Leurognathus marmorata.* In view of this I had the skull of one of my specimens cleaned, but found it to be that of a typical *Desmognathus.* There is consequently no possibility of Doctor Moore's species being the same as the one here described.

though, on the whole, intermediate between *D. nigra* and *fusca*. In some respects it is also intermediate in color, as the upper side, on the whole, is more like that of *D. fusca*, while the under side is approaching that of *D. nigra*.

The granulation of the skin of the head is quite characteristic. In a large series of *D. fusca* and *nigra* it was found to be perfectly smooth, more or less pitted with minute pores. In all the twelve specimens of what I take to be *D. quadrimaculata* the skin on top of the head as well as on the sides of the face, notably the sides of the upper jaws, is distinctly granular, resembling grain leather, and this peculiarity is equally pronounced in old and young specimens alike.

That the specimens here mentioned really belong to Holbrook's *D. quadrimaculata* seems certain. So far as proportions of body and limbs are concerned, Holbrook's plate agrees perfectly with our specimens. The squarish spots in the figure appear considerably more regular than in the specimens before us, among which there is a very great individual variation in this respect, but the dorsal pattern of a couple of the medium-sized specimens is sufficiently close to show that they belong to Holbrook's species.

A NEW PROCELSTERNA FROM THE LEEWARD ISLANDS, HAWAIIAN GROUP.

By Walter K. Fisher.

During the past spring the U. S. Fish Commission steamer *Albatross*, while engaged in deep-sea dredging in Hawaiian waters, made a trip to Laysan Island, and on the return voyage stopped at Necker Island (latitude 23° 35′ 24″ N.; longitude 164° 41′ W.). Here the naturalists of the Expedition were landed. Almost at once we noticed a little gray tern about the rocks, and promptly secured specimens. The same species had previously been seen at sea near the French Frigate Shoals, to the westward. The tern proved to be a new species of the genus *Procelsterna* Lafresnaye,[a] and is here described.

I wish to record my best thanks to Mr. Witmer Stone, of Philadelphia, Pennsylvania, for kindly comparing the type with that of *Anous cinereus* Gould (=*Procelsterna cinerea*) and for giving me measurements, and notes on the literature appertaining to *P. cærulea* (Bennett) and *P. cinerea* (Gould). I am also indebted to Mr. Robert Ridgway, of the U. S. National Museum, for the loan of a specimen of *P. cærulea* and one of *P. cinerea*, which have been of the greatest value; to Mr. J. O. Snyder, who shared the discovery with the writer; and not least to Dr. Charles H. Gilbert, chief of the expedition, who encouraged in every possible way the ornithological side of our work.

PROCELSTERNA SAXATILIS, new species.

NECKER ISLAND TERN.

Specific characters.—Nearest *Procelsterna cinerea* (Gould) but more bluish in color, with darker upper parts, darker breast, sides, flanks, and lower tail coverts, and with pearly gray under wing coverts (instead of white of *cinerea*), shorter and slenderer bill, and shorter wings.

Type.—Adult male, No. 188651, U.S.N.M.; Necker Island (longitude 164° 41′ W.; latitude 23° 35′ 24″ N.), Hawaiian group, May 31, 1902; collected by Walter K. Fisher; orig. no. 143.

[a] Maj. de Zool., (2), Ois., pl. XXIX, cum descript. (1842). Type *Sterna cerulea* Bennett.

Geographic distribution.—Necker Island, French Frigate Shoals, and Bird Island, of the Leeward Islands, Hawaiian group.

Description of type.—Male adult. Bill black. Pileum and fore part of cervix, lores, chin, and throat clear light gray (about No. 8 or 9 of Ridgway's nomenclature), shading to darker (between French gray and cinereous) on nape, cheeks, and sides of neck, and passing into a trifle lighter gray (No. 7) on sides, hind part of jugulum, breast, flanks, and lower tail coverts. Fore part of jugulum and central portion of abdomen pure white, blending into surrounding gray of sides and breast. The breast is almost as pale centrally as the pileum, but becomes gradually darker on sides, shoulders, sides of neck, and malar region inclosing the conspicuously lighter throat and white jugular patch. An orbital ring is black in the anterior two-thirds of upper, in whole of forward, and first third of lower portion, and pure white for the remainder. The black and white are conspicuous, being from 1 to 2 millimeters wide. A small white area occurs just above black portion of orbital ring on "eyebrows." The gray of the nape and hind neck and shoulders shades gradually into a darker and less bluish gray over the mantle (about gray No. 6, or slightly darker), which darkens into a decidedly ashy gray (between slate gray and mouse gray) on wing coverts. Secondaries conspicuously edged with white. The feathers of the mantle are vermiculated with almost obsolete bars of lighter gray (present also in *cinerea* and *cærulea*), which show plainly in favorable lights. Primaries dark slate color, an indistinct light-gray wedge on the inner web of the first three primaries (reaching to within 25 mm. of tip on first), less conspicuous on fourth, and represented on remainder by an indistinct lighter edging. Shafts of primaries very dark sepia. Under wing coverts pearl gray, whitish at bend of wing. Rump, upper tail coverts, and rectrices like mantle. Inner web of each rectrix edged with pale gray distally, becoming almost white proximally (less extended than in *cinerea*). Legs in life dull sepia black, paler toward and on tibiæ and toes, webs creamy flesh color, rather lifeless, with an indefinite edging of sepia next to toes. Iris deep sepia, pupil black.

Measurements of type in millimeters: Length in flesh, 285; wing, 186; tail, 113; culmen, 26; depth of bill at nostril (post. end), 5.5; bill from nostril, 17.5; tarsus, 25; middle toe, 32.

Adult female.—Cotype, No. 188652, U.S.N.M. In color like the male, but a trifle smaller. (For size see table of measurements.)

Immature.—(Female) cotype, No. 188653, U.S.N.M. Upper parts as a whole darker than adult; the pileum of dark feathers edged with gray, giving a mottled appearance; mantle darker and more ashy than adult, lacking faint bars except on longest tertials. Inner tertials and upper tail coverts edged with light gray. Lower parts, as a whole, lighter than adult, being white except an illy defined band across

breast and on throat, which parts are grayish. Sides of head and neck darker than adult. Black portion of orbital ring much wider and more conspicuous than white. White area over orbital ring as in adult. Malar stripe white. Measurements in millimeters: Wing, 157; tail, 80; culmen, 17; tarsus, 23.

Nestling.—Recently hatched (male) cotype, No. 188654, U.S.N.M. Completely covered with soft down. Pure white below. Crown white, sides and back of neck very pale buffy. Ends of wings white; inner portion of alar, and the humeral and spinal tracts brownish gray (down white at tips and brownish gray below). Feet greenish gray, bill black.

Egg.—Bluntly ovate and broadly elliptical ovate (two specimens). Ground color dull creamy white; in one specimen not thickly marked with roundish rod-shaped, Y-shaped, U-shaped and irregular small spots of clay. Color, light sepia, and wood brown, shell marks showing various shades of bluish gray. In this specimen the spots are rather evenly distributed over the whole egg. The other specimen has more numerous smaller and more regular spots about the size of dust shot, which are scattered over the whole egg, but are thicker at the blunt end. The gray spots are larger and more numerous than the brown ones. The two specimens measure 36.5 by 26 and 39 by 27 millimeters.

In some respects the present form is intermediate between *Procelsterna cerulea* (Bennett) and *P. cinerea* (Gould). This is true of the size, in a general way, and also of the color of the under parts. The under parts of *cerulea* are fully as dark as the back, which (in an old skin collected by T. R. Peale, Dog Island, Low Archipelago) is more ashy than that of *saxatilis*. *Procelsterna saxatilis* shows its closer relationship with *cinerea* in the light lower parts and light gray wedges on the four outer primaries. As mentioned above, however, it is smaller than *cinerea*, with conspicuously shorter wing, and shorter and slenderer bill. The under wing-coverts are pearl gray instead of white, and the breast, sides, and lower tail-coverts are decidedly gray, whereas in *cinerea* the lower parts are almost white and entirely so on the belly and lower tail-coverts. The general tone of the plumage of *cinerea* is ashy, but in *saxatilis* it is bluish.

We first saw this handsome tern off the French Frigate Shoals, between Necker and Laysan. Here it undoubtedly nests on a precipitous rock, which rises 125 feet above the sea. It was at this locality that Henry Palmer, Rothschild's collector, mentioned seeing a little gray tern,[a] which he was unable to secure. He probably meant the present species.

We found *Procelsterna saxatilis* very soon after we landed on

[a] Avifauna of Laysan, etc. By Walter Rothschild (Henry Palmer's Diary, Pt. 1, pp. IX and XII).

Necker, May 31. Necker is a dark, forbidding, rather precipitous rock of volcanic origin, attaining a height of 300 feet. It is about seven tenths of a mile long and is shaped like a rude fishhook, the "shaft" extending nearly east and west, the "barb" being a rugged peninsula extending toward the northeast and inclosing a rocky and turbulent cove. The island is entirely composed of lava, mostly of a sooty gray or black, with streaks of dull dark red through it. The sides of the rock, though steep, are intricately terraced, especially on the northeast point, where there are a series of shelves and all sorts of knobs and crannies, making the island ideally fitted for the occupation of birds.

The Necker Island tern was found to be fairly common on Necker, but not so abundant as *Sterna fuliginosa* or *Gygis alba kittlitzi*. We first noted them perched on the rocks near what was probably their nesting site, and recognized them as the curious little terns we had seen off the French Frigate Shoals. A single egg is laid in a shallow recess of the rock, but no nest is made; a few sticks and stray feathers only are sometimes gathered. The eggs were not common. The terns usually perch on the rocks somewhere near the "nest," and it was difficult to find a bird on the egg. In fact only one was actually flushed off the egg, and that by Mr. J. O. Snyder, on the north side of the island. This made the identification of the few eggs we had collected certain. Incubation was so far advanced that we could save only two specimens.

At Bird Island this tern is abundant. We were not able to land on the rock, but saw many of the graceful birds from the deck of the U. S. Fish Commission steamer *Albatross* as they flew back and forth. The stomachs of those collected at Necker contained small silvery fishes.

Its near relative *Procelsterna cinerea* is distributed over "Australian and New Zealand seas, Lord Howe, Norfolk, and neighboring islands, and Kermadec Group; also the islet of San Ambrosio, which is nearest to the coast of Chile, but lies outside the cold Antarctic current,"[a] and Eua, Friendly Islands.[b] *Procelsterna cerulea* is distributed over "Central Polynesia: Paumotu or Low Archipelago, the Marquesas, the Society to the Ellice Islands, the Phoenix group, and the Fannings (Christmas Island), and a little north of the equator."[c] It is of interest, therefore, to note that *Procelsterna saxatilis* is separated from its nearest relative by many thousand miles of ocean, and that a quite different species, *cerulea*, ranges in between.

The statement that some of the characters of *saxatilis* are "intermediate" does not in any way indicate that this species is a connecting link. The form is quite separate from the two other species, and fortunately can not justify the introduction of trinomials into the genus *Procelsterna*.

[a] Saunders, Cat. Birds Brit. Mus., XXV, p. 135. [b] Idem., p. 136. [c] Idem, p. 134.

A table of measurements of 7 adult *Procelsterna saxatilis* is here given, and for comparison measurements of 3 adult *P. cinerea*, including the type, and of the same number of *P. cerulea*.

Table of measurements.

PROCELSTERNA SAXATILIS.

Number.	Sex.	Wing.	Tail.	Culmen.	Bill from nostril.	Depth of bill at nostril.	Tarsus.	Middle toe, with claw.	Locality.
U. S. Nat. Mus. Coll. type 188651.	Male.	186	113	26	17.5	5.5	25	32	Necker Island.
Original No. 148	Male.	186	109	25.2	17	5.5	25	32	Do.
Original No. 144	Male.	185	112	26	17	5.5	25	Bent.	Do.
Original No. 147	Male.	186	115	26.5	17	5. +	25	32	Do.
Original No. 146	Male.	183	109	25	16	5.5	25	32	Do.
Original No. 145	Male.	185	112	25	16.5	5.5	25	32	Do.
U. S. Nat. Mus. Coll. cotype 188652.	Female.	180	110	25. −	16. +	5	24. +	31	Do.

PROCELSTERNA CINEREA.

Number.	Sex.	Wing.	Tail.	Culmen.	Bill from nostril.	Depth of bill at nostril.	Tarsus.	Middle toe, with claw.	Locality.
Phil. Acad. Sci. Coll. type 5032.	....	211	......	28	......	....	......	......	East coast Australia.
Phil. Acad. Sci. Coll. 5033.	....	*a*206. +	......	28	......	....	......	......	Do.
U. S. Nat. Mus. Coll. 15466	....	*a*195. +	......	27	19.5	6.5	25.5	33	

PROCELSTERNA CERULEA.

Number.	Sex.	Wing.	Tail.	Culmen.	Bill from nostril.	Depth of bill at nostril.	Tarsus.	Middle toe, with claw.	Locality.
Phil. Acad. Sci. Coll. 5029.	....	180	......	27	......	....	......	......	Polynesia.
Phil. Acad. Sci. Coll. 5031.	....	178	......	26	......	....	......	......	Do.
U. S. Nat. Mus. Coll. 131532.	....	180	......	25.5	17. +	....	24	30	Dog Island, Low Archipelago.

a Wing tip broken.

THE STRUCTURAL FEATURES OF THE BRYOZOAN GENUS HOMOTRYPA, WITH DESCRIPTIONS OF SPECIES FROM THE CINCINNATIAN GROUP.

By Ray S. Bassler,

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In 1882[a] Mr. E. O. Ulrich established the genus *Homotrypa* for a group of species typified by *H. curvata*, a common and characteristic fossil of the lower Lorraine at Cincinnati, Ohio, and vicinity. In that paper two species were described—the one just mentioned and *H. obliqua*. In subsequent papers this author added twelve species and varieties. Other authors have described four species which have been referred to the genus. In the course of their collecting Messrs. Ulrich and Nickles and the writer have discovered a large number of forms belonging to this genus, which will eventually include not less than fifty species. With so great a specific representation *Homotrypa* may well rank as the most important genus, not only of the *Monticuliporidæ*, but also of the order *Trepostomata*. Moreover, the genus is interesting from both the geologic and biologic standpoints; geologically, because most of the species are common fossils, usually of restricted vertical distribution and thus are good horizon markers; biologically, because many species exhibit remarkably well certain structures which indicate the bryozoan nature of the monticuliporoids. It is the purpose of this paper to point out and describe these structures as studied from thin sections, and to define and tabulate the species found in the Cincinnatian group.

The number of species of trepostomatous bryozoa is so large and their external characters often so similar that it appears a hopeless task to identify them without thin sections, yet it is a mistake to think that thin sections are always necessary. Sections are desirable, but are a necessity only when the internal characters of a new species are being studied. The structures shown in tangential sections are often

[a] Jour. Cincinnati Soc. Nat. Hist., V, 1882, p. 240.

nicely brought out by smoothing the surface of the zoarium with the edge of a knife blade or rubbing upon a gritty stone, and after etching slightly with acid examining with a lens the spot thus treated, moistening it slightly. Similarly, vertical fractures when treated in the same way show the characters seen in vertical sections. By this ready method it is seldom difficult to recognize a *Homotrypa* as the cystiphragms in the peripheral region are easily detected, if not in the tangential, then certainly in the vertical section. Except in the matter of size, the surface characters of the zoœcia are seldom distinctive of any species of *Homotrypa* and are more or less similar in all the species. For that reason, only the zoarium and internal characters of the species here described are figured and only when the surface characters are out of the ordinary are they described. To obtain the number of zoœcia in a given space a measurement is made from the center of one macula to the center of one adjoining. The average of several such measurements gives the correct number, which may be verified by counting the number of zoœcial tubes in the same space in the peripheral region of vertical sections.

HOMOTRYPA Ulrich.

Homotrypa Ulrich, Jour. Cincinnati Soc. Nat. Hist., V, 1882, p. 240; Geol. Sur. Illinois, VIII, 1890, pp. 370, 409; Geol. Minnesota, III, 1893, p. 235; Zittel's Textb. Pal. (Engl. ed.), 1896, p. 273. -Foord, Contr. Micro.-Pal. Cambro.-Sil., 1883, p. 9.—Miller, North American Geol. Pal., 1889, p. 309.—Nickles and Bassler, Bull. U. S. Geol. Survey, No. 173, 1900, p. 29.

The genus has been briefly defined as follows:

Zoarium frondescent or ramose; maculæ or monticules of larger cell apertures a characteristic feature; apertures often oblique; zoœcia with very thin or finely crenulated walls and remote diaphragms in immature region and cystiphragms, isolated or in series, confined to mature region; mesopores few, in clusters; acanthopores generally developed.[a]

The essential generic characters are the upright zoarium, the presence of cystiphragms in the peripheral region only, and the development of few mesopores. The form of the zoarium, the shape and size of the maculæ and zoœcia, and the number of the latter in a given space, thickness of zoœcial walls, distribution of diaphragms and cystiphragms, and the number, size, and distribution of acanthopores and mesopores are the important variable quantities upon which the specific characters are based.

The species of *Homotrypa* may be classed into two well-defined groups, the presence or absence of diaphragms in the peripheral region of the zoœcial tubes being the distinguishing characteristic. In the typical section, which may be designated the *H. curvata* group.

[a] Nickles and Bassler, Bull. U. S. Geol. Survey, No. 173, 1900, p. 29.

diaphragms as well as cystiphragms are present in the peripheral region. The Warren[a] beds of the Lorraine formation show the advent of a group of species in which diaphragms are seldom, if ever, shown in sections either in the axial or peripheral region of the zoœcial tubes. *H. communis*, an abundant Richmond species, may be considered the type of the group, and a glance over the appended table of species will show that this section will include *H. bassleri* and *H. libana* from the Lorraine, and *H. dawsoni*, *H. communis*, *H. nodulosa*, *H. austini*, *H. cylindrica*, and *H. richmondensis* from the various divisions of the Richmond. Whether the diaphragms were membraneous and not capable of preservation, or whether they were not developed at all, can not be determined. Associated species of the genus show diaphragms well developed in either the peripheral or in both regions, and this fact would seem to indicate that their absence in this group is of structural importance. A subdivision of the *H. communis* group is suggested under the discussion of the cystiphragm.

The typical section of the genus, the *H. curvata* group, includes all of the described species and the new forms of this paper with the exception of those mentioned above. It is by far the more important group, and ranges through the Mohawkian and Cincinnatian groups, while the *H. communis* section is confined to the upper Lorraine and Richmond.

THE CYSTIPHRAGM.

The peculiar structures which were termed cystiphragms by Ulrich are well developed in *Homotrypa* and constitute a generic feature. These cystiphragms, or cystoid diaphragms as formerly termed, occupy

[a] The subdivisions of the Cincinnatian group recognized in this paper are those published by Nickles (Jour. Cincinnati Soc. Nat. Hist., XX, 1902, pp. 49–100). For convenience of reference the classification is here repeated.

Cincinnatian	Richmond	Upper beds.
		Middle beds.
		Lower beds.
	Lorraine	Warren beds.
		Mount Auburn beds.
		Corryville beds.
		Bellevue beds.
		Fairmount beds.
		Mount Hope beds.
	Utica	Upper beds.
		Middle beds.
		Lower beds.

The Richmond strata exposed in Illinois, Wisconsin, Minnesota, and Manitoba, and termed the northwestern Richmond in the appended tables, are here correlated with the Upper beds of Nickles's classification.

generally one side of the zoœcial cavity as a series of superimposed vesicles. When tangential sections cut these vesicles, they show within and extending across the zoœcial cavity, a curved line, the amount of curvature depending upon the gibbosity of the cystiphragm. In *H. callosa* Ulrich, and *H. ramulosa* (see Plate XXV, fig. 3) this line is but slightly curved, showing that the vesicle was little rounded. In the type species the vesicle is of such a shape and occupies so much space as to cause the cut edge shown in tangential sections to extend around about two-thirds of the circumference of the zoœcial chamber. A different style of cystiphragm occurs in such species as *H. pulchra* and *H. cincinnatiensis*. Here, occasionally, the cystiphragm extends entirely around the bounding wall but leaves the central portion of the zoœcial cavity unoccupied, and here ordinary horizontal diaphragms are developed. In this case, tangential sections (Plate XX, fig. 12, Plate XXI, fig. 7) show the cystiphragm as a more or less rounded, central ring. In vertical sections the cystiphragms appear as semicircular lines lining usually one side of the zoœcial tube, but when the vesicles extend entirely around the cell cavity both sides show a series of curved lines.

The portion of the peripheral region of the zoœcial tube not occupied by the cystiphragms is generally intersected by transverse partitions, the diaphragms, which may or may not be as numerous as the cystiphragms, seldom however exceeding them in number. It is also to be noticed that in forms showing no diaphragms in the zoœcial tubes the cystiphragms seldom overlap, the lower end of one not reaching to the next below. If this interpretation is true to nature it would imply that the cystiphragms were open at the bottom. However, one or both of the following explanations may account for this appearance. The cystiphragms are seen in vertical sections to be thickest at the upper end, and often are reduced in thickness to extreme thinness at the point of overlap. In the forms under discussion the lower part of the cystiphragm may have been so thin that sections do not reveal it at all. Another interpretation is that suggested by Nickles in the description of *H. bassleri*, that calcification in the living state was more or less incomplete.

Upon the basis of the distribution of the cystiphragms the *H. communis* group of the genus may be further subdivided into two sections, one in which cystiphragms line the peripheral region of all the zoœcia, and another in which the zoœcial tubes of the maculæ only are provided with cystiphragms, as seen in sections of *H. austini*. The latter, an unusual occurrence, may throw some light upon the functions of both maculæ and cystiphragms. Ulrich has considered the maculæ (including the monticules and groups of larger zoœcia, all of which are evidently identical in function) of trepostomatous bryozoa to be connected in some way with reproduction, these groups perhaps

being set aside for that purpose. In *Criocara ramosa* of the Cretaceous (see Plate XX, figs. 5, 6), ovarian-like vesicles, very similar to cystiphragms, have been found, and this fact leads to the belief that the cystiphragm also had a reproductive function. Hence the restriction of these structures in this species to the zoœcial tubes of the maculæ only may have some significance.

THE ACANTHOPORE.

The majority of the species of *Homotrypa* exhibit these spine-like structures—the acanthopores. The ordinary acanthopore when showing at the surface is seen to be a blunt spine situated on the cell wall, usually at the angle of junction of adjoining zoœcia.

Tangential sections show that this spine is composed of concentric rings of laminated tissue inclosing a minute, round canal. A vertical section brings out the fact that the spine is not a mere surface ornament, but that it is a tube inclosed in the wall substance of the zoœcium; that this tube is developed generally with the mature region and continues as an independent structure to the surface. In some species they are well developed and here exhibit their structure most clearly. The acanthopores of *H. nodulosa* and *H. cylindrica* of this paper show all that has been learned concerning these structures. That of *H. nodulosa* viewed in a tangential section (Plate XXIII, fig. 7) differs from the ordinary form in having a comparatively large central space, the diameter of this sometimes being as much as one-half that of the entire structure. A vertical section (Plate XXIII, figs. 5,6) shows clearly that the acanthopore is not only a tube, but that this tube is also crossed by thin transverse partitions about the tube diameter distant from each other. Such a section also shows that instead of being limited to the mature region, the acanthopore may develop in any part of the immature region, pass through in turn both this and the mature region, and then, instead of stopping with the zoarial growth to which it belongs, continue through the immature and mature regions of an incrusting, secondary growth of the species if this be present. This section also shows that the concentric rings seen in tangential sections surrounding the central space are the cut edges of overlapping, conical layers of tissue forming the wall of the tube. The acanthopore of *H. cylindrica* (Plate XXII, fig. 10) is interesting because it shows to how great an extent these conical layers may be developed and, in contrast with preceding species, how minute the central cavity may be. Yet even in this species, in which the diameter of the tube is generally less than one-twentieth that of the entire acanthopore, the transverse partitions may be seen under favorable circumstances.

Possessing such structure, it must be conceded that the acanthopores were of no little importance to the zoarium. Just what their function

was is not known, but, as suggested by Ulrich, they may have supported appendages similar to the avicularia or vibracula of recent bryozoa. They certainly are not, as considered by Waagen and Wentzel,[a] mere thickenings preceding gemmation. Nor do they give rise to mesopores, which in turn develop into true zoœcia as schematically illustrated by these authors. In actual sections such a development is not known, and among the thousands of thin sections of trepostomatous bryozoa examined by the writer, not one has been seen that in anywise countenanced their interpretation. The zoœcia, mesopores, and acanthopores of these fossil forms are as distinct and independent structures as are the polypides, avicularia, and vibracula of recent chilostomatous bryozoa, whose wholly distinct morphological development has been demonstrated by students of living species.

COMMUNICATION PORES AND INTERMURAL STRUCTURE.

Under certain conditions tangential sections indicate that the zoœcial walls and the intermural space are seemingly pierced by communication pores or connecting foramina. These were first recorded by Ulrich in the descriptions of *H. curvata* and *H. obliqua*. Dr. Rominger, in a critical paper,[b] subsequently denied the presence of these pores. I have figured tangential sections of *H. wortheni* and *H. nodulosa* (Plate XXIV, fig. 12; Plate XXV, fig. 15) which show that such structures do exist in *Homotrypa* and are found in other species than those mentioned by Ulrich. Indeed, they have been found in so many species of this genus that their presence may be considered a generic feature. These pores are best observed when the section is rather thick. As the section is thinned the pores become less distinct, and when very thin disappear altogether. This is because the denser tissue of the zoœcial walls in thick sections brings out into relief the clearer substance of the connecting foramina, but as the section is thinned the substance of the walls becomes more and more translucent, until, finally, both wall and pore are alike in clearness and the outline of the latter is lost.

Thin sections show that each zoœcium has its own bounding wall distinct from adjacent zoœcia, the space between, which is here termed the intermural space, being occupied by the acanthopores and a dotted or granular layer, which in sections has a structure very similar to that exhibited by the parenchymal chord of more recent bryozoa (see Plate XX, fig. 2). The width of this intermural space varies with the species and with the age of the zoœcia. Sometimes, even in the fully matured condition, it is represented by merely a fine granular line (Plate XX, fig. 1), but in some species (see *H. austini*, Plate XXIV

[a] Paleontologia Indica, 13th Ser., XIII, 1886, pp. 861, 871.
[b] Studies on Monticulipora, American Geologist, VI, 1890, p. 118.

fig. 5) its width often equals that of the zoœcium itself. Often the granules or dots are arranged in regular, transverse lines, and give a very pretty appearance in sections. Figures 2, 3, and 4, on Plate XX, show similar intermural structure in *Retepora columnifera* Busk, a chilostomatous bryozoan, and in *Escharopora pavonia* (D'Orbigny) a typical example of the order *Cryptostomata*.

The following tables, showing the geologic and geographic distribution and the specific characters, are here introduced to aid in the identification of the species:

Geologic distribution of species.

[cc, very common; c, common; nr, not rare; r, rare.]

Species.	Utica.			Lorraine.						Richmond.			Geographic distribution.
	Lower.	Middle.	Upper.	Mount Hope.	Fairmount.	Bellevue.	Corryville.	Mount Auburn.	Warren.	Lower.	Middle.	Upper and northwestern.	
H. curvata praecipta		r	r										Ohio, Kentucky, and Indiana.
H. curvata					cc								Do.
H. cincinnatiensis					cc								Ohio and Kentucky.
H. dumosa					r								Do.
H. flabellaris										cc	cc	c	Ohio, Kentucky, Indiana, Tennessee, Illinois, Wisconsin.
H. flabellaris spinifera					cc					cc	cc		Ohio, Kentucky, Indiana, Tennessee, Wisconsin.
H. obliqua					cc	cc	c						Ohio, Indiana, and Kentucky.
H. grandis								cc					Tennessee.
H. pulchra								cc					Ohio.
H. bassleri									c				Do.
H. libana									c				Do.
H. frondosa									rr				Ohio and Indiana.
H. dawsoni										r			Do.
H. communis										cc			Do.
H. nodulosa										cc	r		Do.
H. richmondensis										cc	c		Do.
H. austini											c		Ohio.
H. wortheni											cc		Ohio and Indiana.
H. wortheni intercellata											c		Indiana.
H. wortheni prominens											c		Do.
H. cylindrica											nr		Ohio and Indiana.
H. ramulosa											nr		Indiana.
H. nicklesi											nr		Kentucky.
H. nitida											c		Indiana.
H. splendens												nr	Illinois.
H. gelasinosa												r	Do.

Table of Specific Characters.

Species.	Growth.	Surface of zoarium.	Number of zoœcia in 2 mms.	Acanthopores, size, number.	Diaphragms in axial region.	Diaphragms in peripheral region.	Cystiphragms.	Additional features.
H. curvata præcipta	Small, ramose	Smooth	10	Small, numerous.	Moderate number.	Numerous	Numerous	
H. curvata	Broad, compressed branches	....do	10	Small, moderate	....do	....do	....do	
H. cincinnatiensis	Small, subcylindrical.	....do	9	Small, numerous.	Absent	Moderate number.	Moderate number.	A moderate number of mesopores among maculæ and zoœcia.
H. dumosa	Small, palmate branches.	Monticulated	7–8	Small, few	....do	Few	Few	Maculæ conspicuous.
H. flabellaris	Flabellate	Smooth	9	....do	Moderate number.	Numerous	Numerous	
H. flabellaris spinifera	....do	Not monticulated	9	Large, numerous.	....do	....do	....do	Surface rough because of very large acanthopores.
H. obliqua	Cylindrical	More or less tuberculated.	10	Small, moderate	Absent	....do	....do	
H. grandis	Large, subcylindrical.	Smooth or low monticules.	9	Small, very numerous.	....do	....do	....do	Cystiphragms restricted mainly to bend from axial to peripheral region.
H. pulchra	Large, expanded fronds.	Smooth	7–8	Absent	Moderate number.	Crowded	Crowded	
H. bassleri	Small, ramose	Tuberculated	10	Small, moderate	Absent	Absent	Moderate number.	
H. libana	Small, thin fronds	Smooth	8–9	Small, few	....do	....do	....do	Mesopores present among both zoœcia and maculæ.
H. frondosa	Flabellate	Monticulated	10	Small, very few.	....do	Moderate number.	....do	Monticules, large, rounded.
H. dawsoni	Large, broad fronds.	....do	8–9	....do	....do	Absent	Few	
H. communis	Large, subcylindrical.	Smooth	9	Medium, numerous.	....do	....do	....do	Cystiphragms usually developed only in bend from axial to peripheral region.
H. nodulosa	Ramose, cylindrical.	Small, sharp tubercles.	9	Two sets, numerous.	....do	....do	....do	Two sets of acanthopores, large and small; numerous tabulated mesopores.
H. richmondensis	Ramose	More or less tuberculated.	8	Small, numerous.	....do	....do	Moderate number.	
H. austini	Small, cylindrical	Smooth	9–10	Medium, numerous.	....do	....do	Few	Cystiphragms developed in maculæ only.
H. wortheni	Ramose, cylindrical.	Sharply tuberculated.	9	....do	....do	Moderate number.	Moderate number.	
H. wortheni intercellata	....do	....do	9	Small, numerous.	....do	....do	....do	Mesopores abundant; axial walls crinkled.

Table of Specific Characters—Continued.

Species.	Growth.	Surface of zoarium.	Number of zoœcia in 2 mms.	Acanthopores, size, number.	Diaphragms in axial region.	Diaphragms in peripheral region.	Cystiphragms.	Additional features.
H. wortheni prominens ...	Subcompressed branches	Elongate monticules.	9	Medium, numerous.	Absent	Moderate number.	Moderate number.	Monticules very prominent, elongate.
H. cylindrica	Long, cylindrical.	Smooth to tuberculated.	9	Very large, numerous.	.....do	Absent	Numerous	Large acanthopores with central tube very narrow and crossed by thin partitions.
H. ramulosa	Large, subcylindrical	Low, broad monticules.	10–11	Small, few	.....do	Numerous	.....do	Cystiphragms in tangential sections, very straight.
H. nicklesi	Subcylindrical, frequently branching.	Smooth	9	Small, very few.	.....do	.....do	.....do	
H. nitida	Small cylindrical stems.	.....do	10	.....do	Few	Moderate number.	Moderate number.	
H. splendens	Flabellate	Monticulated	7	Wanting	Moderate number.	Numerous	Numerous	Walls of axial region very thin, of peripheral very thick.
H. gelasinosa	Thin fronds	Smooth	10	Small, few	Few.	Moderate number.	Moderate number.	Maculæ very large and pronounced.

DESCRIPTIONS OF SPECIES.

HOMOTRYPA CURVATA Ulrich.[a]

Homotrypa curvata Ulrich, Jour. Cincinnati Soc. Nat. Hist., V, 1882, p. 242, pl. x, figs. 7–7d.

In growth this species is between the cylindrically ramose species and the truly frondescent forms as *H. flabellaris*. Acanthopores, cystiphragms, and diaphragms are present in a moderate degree. The external characters by which the species may be recognized are the compressed, flattened branches and smooth surface; in thin sections, by the average number of acanthopores (three or four surrounding a zoœcium), absence of mesopores except in the maculæ, ten zoœcia in 2 mm., the presence of diaphragms in the axial region, and of both diaphragms and cystiphragms in the peripheral region.

Occurrence.—A common and characteristic fossil in the Fairmount beds of the Lorraine at Cincinnati, Ohio, and vicinity.

Cat. Nos. 41729–41734, U.S.N.M.

HOMOTRYPA CURVATA var. PRÆCIPTA, new variety.

Plate XXIII, fig. 15.

This varietal name is proposed for the only *Homotrypa* known in the Utica. It has the internal characters of *H. curvata*, but differs in the growth of the zoarium. Its branches are cylindrical, smooth, about 6 mm. in diameter, and divide at short intervals, while the zoarium of *H. curvata* takes the form of broad, compressed branches, dividing at less frequent intervals. Thin sections show that the Utica form generally exhibits more acanthopores, but the number of acanthopores varies slightly in every species.

Occurrence.—Rare in the middle division of the Utica at West Covington, Kentucky. Cumings[b] records the same form from the Upper Utica.

Cat. No. 41735, U.S.N.M.

HOMOTRYPA OBLIQUA Ulrich.

Plate XXIII, figs. 12–14.

Homotrypa obliqua Ulrich, Jour. Cincinnati Soc. Nat. Hist., V, 1882, p. 243, pl. x, figs. 6–6b.

This abundant Lorraine species in its internal characters is very much like *H. curvata*. The absence of diaphragms and the slightly crinkled walls in the axial region distinguish it from *H. curvata*.

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[a] Under species heretofore described, the reference to the original description only is given. The complete synonymy is presented in Bulletin No. 173, U. S. Geological Survey, 1900.

[b] American Geologist, XXIX, 1902, p. 215, footnote.

Externally, however, the two species are readily separated by their different methods of growth, the ramose zoarium of *H. obliqua* with its cylindrical or slightly compressed, more or less tuberculated, branches being quite characteristic. In the Fairmount beds of the Cincinnati area a form of the species with strongly tuberculated, cylindrical branches seldom over 5 or 6 mm. in diameter, occurs very abundantly. The succeeding Bellevue beds also hold the species in abundance, but here the zoarium is more robust and the branches are often subcylindrical and nearly smooth. Specimens 6 cm. or more in length without dividing and 15 mm. in diameter are often found. The prevailing form of zoarium in the Corryville beds is a rather broad, somewhat compressed, tuberculated branch, and specimens of this kind probably led Nicholson to identify *H. dawsoni* at Cincinnati. The internal structure of these various forms of the species is essentially the same. About 10 zoœcia in 2 mm.

Occurrence.—An abundant species of the above-mentioned divisions of the Lorraine at many localities in the Cincinnati area. The typical form occurs in the Bellevue beds.

Cat. Nos. 41736–41740, U.S.N.M.

HOMOTRYPA CINCINNATIENSIS, new species.

Plate XXI, figs. 4–10.

Zoarium small, generally less than 3 cm. in height, ramose, dividing rather regularly at short intervals; branches subcylindrical but with a tendency to become frondescent, 2 to 4 mm. thick and 3 to 9 mm. wide. Surface commonly smooth, the clusters of usually larger cells rarely forming low monticules. Zoœcial apertures angular, direct, about nine in 2 mm. A moderate number of mesopores present both in the clusters and elsewhere. Acanthopores small, varying in number, sometimes as many as eight or ten surrounding a zoœcium. Diaphragms and cystiphragms rather numerous and developed in the peripheral region only.

The shape of the zoarium, the small cells and smooth surface characterize this species. The points of difference from *H. dumosa*, probably its nearest relative, are indicated under the description of that form.

Occurrence.—Common in the Fairmount beds of the Lorraine formation at Cincinnati, Ohio, and vicinity. Apparently the same form occurs at Maysville and McKinneys, Kentucky, at the same horizon.

Cat. Nos. 41742–41746, U.S.N.M.

HOMOTRYPA DUMOSA, new species.

Plate XX, fig. 1; Plate XXI, figs. 1–3.

Zoarium consisting usually of small, inosculating, palmate branches, an average entire colony being 5 cm. high and from 3 to 5 cm. in width;

occasionally larger expanded fronds occur that do not seem to inosculate. Surface with very distinct clusters of large cells, usually raised into low monticules, but sometimes sharp tubercles. Zoœcial apertures angular, direct or nearly so, inclosed by thin walls, seven to eight in 2 mm. Mesopores few, usually restricted to the cell clusters. Acanthopores seldom showing at the surface, but tangential sections reveal a limited number, best developed in the clusters. Zoœcial tubes with walls thin and less crinkled than usual in the axial region and thickened slightly in the peripheral region, where a few diaphragms and rather large cystiphragms are developed.

The characteristic features of this species are its thin walls, comparatively large zoœcia, and conspicuous clusters. *H. cincinnatiensis*, with which this form might be confused, is distinguished by a different mode of growth, smaller zoœcia, less conspicuous clusters, and more abundant mesopores and acanthopores.

Occurrence.—Rather rare in the Fairmount beds of the Lorraine formation at Covington, Kentucky, and Cincinnati, Ohio.

Cat. No. 41741, U.S.N.M.

HOMOTRYPA PULCHRA, new species.

Plate XX, figs. 11–14.

Zoarium large, consisting of expanded fronds, subdividing or sending off other fronds, and ranging from 5 to 10 or more cm. in height; fronds 3 to 5 mm. in thickness and sometimes as much as 8 cm. in width. Surface smooth, the clusters scarcely ever rising above the general surface, but nevertheless conspicuous on account of the large size of their cells. Zoœcial apertures thin walled, angular, direct, seven to eight in 2 mm. An occasional mesopore is developed, but only in the clusters. Acanthopores are apparently always wanting, although the thickenings sometimes seen at the angles of junction simulate these structures. Diaphragms from 1 to 1½ tube diameters apart in the axial region and four or five times as numerous in the peripheral region. Cystiphragms in an increasingly crowded series in the peripheral region and extending close to the surface.

This fine species can be readily distinguished externally by its handsome mode of growth, smooth surface, large and thin-walled zoœcia, and conspicuous clusters; internally, by the absence of acanthopores and the unusual development of diaphragms and cystiphragms, of which the outermost are commonly visible at the surface. It is scarcely necessary to distinguish this from other species. *H. curvata* bears a slight resemblance in growth, but differs in all other features.

Occurrence.—A characteristic and common fossil restricted to the *Platystrophia lynx* horizon of the Mount Auburn beds, Lorraine formation, at Cincinnati and Lebanon, Ohio, and other localities. At Cincinnati this bed occupies the tops of the highest hills.

Cat. Nos. 41747, 41748, U.S.N.M.

HOMOTRYPA GRANDIS, new species.

Plate XX, figs. 7–10.

Zoarium large, 10 cm. or more in height, subcylindrical or compressed, branching rather frequently, an average example being 2 cm. in width and half as much in thickness. Surface generally smooth, but sometimes exhibiting low rounded monticules. Apertures polygonal, direct, thick walled, nine in 2 mm. Mesopores restricted to the maculæ. Acanthopores inconspicuous at the surface, but in thin sections they are seen to be small and very numerous, as many as sixteen sometimes surrounding a zoœcium. Intermural space finely dotted, the dots often arranged in transverse rows. In tangential sections the polygonal zoœcia with their numerous, regularly arranged acanthopores and intermural dots present a very pretty appearance. In vertical sections the zoœcial tubes show thin crinkled walls in the axial region, and develop diaphragms only as the peripheral region is approached. In the early part of the latter region, especially in the bend from the axial to the peripheral, numerous cystiphragms and diaphragms are developed, but in the remainder of the long mature region only an occasional cystiphragm is seen, while diaphragms continue as numerous as before.

In the mode of development of diaphragms and cystiphragms this species resembles *Homotrypella*, but otherwise it has the characters of *Homotrypa*. The large subcompressed branches, the numerous, small acanthopores, the intermural structure, and the unusual disposition of diaphragms and cystiphragms are characteristic of the species.

Occurrence.—Abundant in the *Platystrophia lynx* horizon of the Lorraine formation exposed along Lumsleys Fork, 2 miles west of Goodlettsville, Davidson County, Tennessee.

Cat. No. 41764, U.S.N.M.

HOMOTRYPA BASSLERI Nickles.

Homotrypa bassleri Nickles, Jour. Cincinnati Soc. Nat. Hist., XX, 1902, no. 2, p. 103, figs. 1–5.

The small, cylindrical or slightly flattened tuberculated branches, small zoœcia (ten in 2 mm.), and internally the presence of cystiphragms unaccompanied by diaphragms characterize this species.

Occurrence.—A rather common and characteristic fossil of the upper part of the Warren beds, Lorraine formation, at Lebanon and Oregonia, Ohio.

Cat. No. 34330, U.S.N.M.

HOMOTRYPA LIBANA, new species.

Plate XXII, figs. 1–3.

Zoarium, composed of small, thin, flat fronds, the most complete example seen being 5 cm. high, 3 cm. at its greatest width, and less

than 3 mm. in thickness. Surface smooth, with maculæ of decidedly larger zoœcia. Apertures thin walled, direct, eight to nine in 2 mm. Acanthopores not observed at the surface. Mesopores of not infrequent occurrence both in the maculæ and among the ordinary zoœcia. Internal characters: Diaphragms practically wanting in both regions. Axial region with thin crinkled walls, which are but slightly thickened in the short peripheral zone. A series of generally four cystiphragms is developed in the peripheral region of each zoœcial tube. Acanthopores rather few and inconspicuous, generally situated at the junction angles of the zoœcia.

The smooth, thin, flat fronds will distinguish this neat species from the associated *H. bassleri*. There is no other species sufficiently related to require comparison.

Occurrence.—Not uncommon in the Warren beds of the Lorraine formation at Lebanon, Ohio.

Cat. No. 34329, U.S.N.M.

HOMOTRYPA FRONDOSA, new species.

Homotrypa frondosa (neither *Monticulipora frondosa* D'Orbigny nor *Chætetes frondosus* Edwards and Haime.) Cumings, American Geologist, XXIX, 1902, p. 208, pl. x, figs. 11, 12; pl. xi, figs. 2, 5; pl. xii, fig. 1.

In 1850 D'Orbigny proposed *Monticulipora frondosa*,[a] based on specimens said to have been found at Cincinnati and Oxford, Ohio. In 1851 Milne-Edwards and Haime redefined and figured the species as *Chætetes frondosus*,[b] basing their description it seems upon the same specimens used by D'Orbigny. Since the internal characters are not described in either case, and as there are several forms of different genera with which *M. frondosa* might be identified, it is probably impossible without the aid of the type specimen to definitely fix upon D'Orbigny's species. The status of the species was further complicated by Nicholson in redefining D'Orbigny's *Monticulipora mammulata*,[c] since, as shown later by Ulrich, he really described a species more like *M. frondosa*. Recently Cumings identified D'Orbigny's, or rather Edwards and Haime's, species with a rare form of *Homotrypa*, found in the "very top of the Lorraine or base of the so-called Richmond formation."

An effort to find D'Orbigny's type specimens is now being made, and should this succeed the standing of his species will be adjusted. However, for the present I prefer to adhere to Ulrich's identification of *Monticulipora frondosa*, and Cumings's *Homotrypa frondosa* is here recognized as a new species, preserving that writer's name.

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[a] Prodr. de Pal., I, p. 25.

[b] Pol. Foss. Ter. Pal., 1851, p. 267, pl. xix, figs. 5, 5*a*.

[c] Quar. Jour. Geol. Soc. London, 1874, p. 508.

Homotrypa frondosa belongs to the typical group of the genus and should be compared with *H. flabellaris*. The flabellate growth, large rounded monticules, few acanthopores, and the presence of both diaphragms and cystiphragms in the peripheral region are characteristic features.

Occurrence.—Rare in the Warren beds of the Lorraine formation in Indiana and Ohio. Harmans Station, Indiana, is the type locality.

HOMOTRYPA FLABELLARIS Ulrich.

Homotrypa flabellaris Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 411, pl. xxxii, 3–3c.

This species with its varieties has quite a range, both geologically and geographically, specimens being found, generally abundantly, in the Lorraine and Richmond at many localities in the Mississippi Valley. The species was described from specimens found in the Richmond at Wilmington, Illinois. The figured sections illustrating the internal structure were prepared from a colony in which the mature region was not fully developed. Mature specimens show a moderately crowded series of cystiphragms and diaphragms in the peripheral region. If the large acanthopore was omitted from our fig. 14, on Plate XXI, it would show the characters seen in a vertical section of this species. The specific characters are the flabellate growth, smooth surface, nine zoœcia in 2 mm, few small acanthopores, mesopores tabulated, numerous in the maculæ and not uncommon among the ordinary zoœcia, a moderate number of diaphragms in the axial region and a well-developed series of diaphragms and cystiphragms in the peripheral region.

Occurrence.—A common species in the Lorraine and Richmond formations of Illinois, Indiana, Ohio, Kentucky, Tennessee, and Wisconsin.

Cat. Nos. 40217–40223 Harris collection, 41772, 41774–41777, 41780–41782, U.S.N.M

HOMOTRYPA FLABELLARIS var. SPINIFERA, new variety.

Plate XXI, figs. 11–15.

This variety agrees with *H. flabellaris* in all essential characters save one, namely, that at rather regular intervals among the zoœcia very large acanthopores are developed, the place of a zoœcium often being occupied by one. This gives the otherwise smooth surface of the zoarium a spiny aspect. The acanthopores often originate in the axial region and proceed to the surface irrespective of the course of the zoœcia.

Occurrence.—Abundant in the Fairmount beds of the Lorraine at Cincinnati, Ohio, and vicinity, and in the Richmond at Richmond, Indiana, Oxford and other localities in Ohio.

Cat. Nos. 41773, 41778, 41779, 41783, U.S.N.M.

HOMOTRYPA DAWSONI (Nicholson).

Plate XXV, figs. 9, 10.

Monticulipora (*Heterotrypa*) *dawsoni* Nicholson, 1881. Genus Monticulipora, p. 141, pl. v, 3–3 f.

With the exception of one feature this fine species was well described and figured by Nicholson. His vertical section (Plate V, fig. 3 e) shows complete diaphragms in the mature region, and in his description he says of that region, "a moderate number of complete horizontal tabulæ being developed;" and again, "tabulæ are in all cases complete and approximately horizontal." The normal condition of the species, as seen in vertical sections, is shown in our figure 9 of Plate XXV. The cystiphragms are here seen to be large and rather irregularly developed or altogether absent, but in the zoœcial tubes of the maculæ a full series is usually present. Diaphragm-like structures occur, particularly in the outer part of the peripheral region, but these are probably cystiphragms, which, extending almost across the cell cavity, give in certain sections the appearance of true diaphragms. In the section, figured by Nicholson, apparently all of the cystiphragms presented this appearance. An entire zoarium, with its broad frond and prominent, closely set monticules, is a handsome cabinet specimen.

Occurrence.—A characteristic but rather uncommon fossil of the Lower Richmond in Ohio and Indiana, Waynesville, Ohio, being the type locality. The species has been recorded as coming also from Cincinnati. This is now known to be erroneous, the Lorraine form so identified being a broad, monticulated variety of *H. obliqua*, externally quite similar, but internally very different.

Cat. Nos. 41749–41752. U.S.N.M.

HOMOTRYPA COMMUNIS, new species.

Plate XXIII, figs. 1–4.

Zoarium of subcylindrical or more commonly compressed branches from 5 to 10 cm. high and 4 to 8 mm. in thickness. Surface smooth, with clusters composed of larger cells and mesopores. Apertures direct, polygonal, rather thick-walled, with about nine in 2 mm. Acanthopores seldom seen on the surface, but sections show a zoœcium to be surrounded by from four to seven. Walls thin and crinkled in the axial region, much thickened in the peripheral. Diaphragms wanting in both regions. Cystiphragms few, generally restricted to the region transitional to the mature condition.

Externally this species sometimes resembles *H. curvata*, but internally is very different. The only associated form with which it might be confounded is *Bythopora meeki* (James), which often bears a superficial resemblance. Sections show the two species to be very distinct.

Occurrence.—A common fossil in the lower part of the Richmond

formation at Oregonia, Waynesville, Clarksville, Hanover, and other localities in Ohio and at several localities in southeastern Indiana.

Cat. Nos. 40234–40236 Harris collection, 41755, 41756. U.S.N.M.

HOMOTRYPA RICHMONDENSIS, new species.

Plate XXIV, figs. 1–4.

The more or less prominent tubercles, few mesopores, numerous acanthopores, and absence of diaphragms are characteristic of this species. The zoarium consists of ramose, somewhat flattened branches, varying from smooth to slightly tuberculated. Zoœcia thin-walled, eight in 2 mm. Acanthopores numerous, small. Mesopores few, as a rule restricted to the clusters. Diaphragms wanting; cystiphragms well developed.

Although resembling several species in one or more details, the combination of characters readily distinguishes this form. For example, specimens of *H. wortheni*, with the tubercles poorly developed, are very similar externally, but internally are distinguished by the presence of diaphragms.

Occurrence.—Not uncommon in the lower and middle divisions of the Richmond formation at Richmond and Versailles, Ind.; and at Hanover, Oxford, and other localities in Ohio.

Cat. Nos. 41784–41787. U.S.N.M.

HOMOTRYPA NODULOSA, new species.

Plate XXIII, figs. 5–11; Plate XXV, fig. 15.

Zoarium ramose, growing from an expanded base attached to other organisms; branches cylindrical or slightly compressed, 2.5 to 6 mm in diameter. Surface with small, well-marked, sharp tubercles, and bristling with large acanthopores. Apertures irregularly polygonal, direct, thin-walled, about nine in 2 mm. At the surface there are two sets of acanthopores, one set very large, perforated, and distributed at rather regular intervals, the other much smaller and more numerous. Tangential sections seldom show the smaller set because of their shortness. Mesopores numerous, though less so when the acanthopores are greatly developed. Walls thin in the axial region and considerably thickened in the peripheral. Cystiphragms sparingly developed and restricted to the early portion of the mature region. Diaphragms wanting in the zoœcial tubes, but abundant and much thickened in the mesopores. Vertical sections show that the large acanthopores may arise in the axial region and proceed at various angles to the surface, and are crossed by thin, transverse partitions. The structures supposed to be communication pores are often seen in tangential sections.

This species is particularly interesting because of the unusual development of acanthopores and mesopores. Some specimens, however, exhibit few mesopores at the surface, and these in vertical sections show that as the surface is approached the mesopores close, while tangential sections have a strong development of acanthopores. Other specimens show at the surface few acanthopores and many mesopores, so that some relationship seems to exist in the development of these structures. Externally the acanthopores form the distinguishing character, producing the sharp, knotty tubercles and the spinulose surface. Under a lens the tubercles are seen to be clusters of a few slightly larger cells, scarcely raised above the general surface and bearing one or two large perforated acanthopores at their summits, these acanthopores causing the knotty appearance.

Occurrence.—A common form in the lower part of the Richmond formation at Hanover, Ohio, and less abundant in the middle division at Richmond, Indiana.

Cat. Nos. 40227–8 Harris collection, 41753–4, U.S.N.M.

HOMOTRYPA WORTHENI (James).

Plate XXIV, figs. 10–14.

Monticulipora (*Monotrypa*) *wortheni* James, Paleontologist, No. 6, 1882, p. 50; No. 7, 1883, pl. I, fig. 2.

James's description and figures of *M. wortheni* are scarcely sufficient to recognize the species or even to place the form generically. The following description is based on material identical with specimens of *M. wortheni* in the collections of the U. S. National Museum with Mr. James's label attached.

Zoarium ramose, branches cylindrical, usually about 6 mm. in diameter and dividing frequently and rather regularly. Surface marked with strong, prominent tubercles, usually 2 mm. apart. Apertures polygonal, direct, rather thick walled, about nine in 2 mm. Mesopores in the typical form few, although in the variety described below they are quite numerous. Acanthopores numerous, often inconspicuous at the surface, but blunt when present.

In tangential sections the striking characters are the thick walls, numerous acanthopores, and wide intermural space with its dotted structure. Here also communication pores are well shown. Vertical sections show that the walls in the axial region are thin and rather straight, but become greatly thickened in the peripheral, where a series of cystiphragms larger than usual is developed with a corresponding number of diaphragms.

The sharply tuberculated branches of this fine species readily distinguish it from associated forms. *H. bassleri* is quite similar externally, but the different internal characters, the few acanthopores, and

absence of diaphragms especially, will distinguish it. *H. tuberculata* Ulrich, from the Black River shales of Minnesota, also has a similar zoarium, but in other respects is quite different.

Occurrence.—A very abundant and characteristic fossil of the middle division of the Richmond in Ohio and Indiana. James's specimens were recorded from Lynchburg, Highland County, Ohio. Other localities are Oxford, Waynesville, and Oregonia in Ohio and Richmond, Indiana.

Cat. Nos. 40224, 40226 Harris collection, 41765, 41766, U.S.N.M.

HOMOTRYPA WORTHENI var. INTERCELLATA, new variety.

Plate XXIV, fig. 17.

This seems to be a constant and well-marked variety, agreeing with *H. wortheni* in its general zoarial characters, but differing in having the walls more crinkled in the axial region and an abundance of mesopores and small acanthopores in the peripheral. Viewed under a lens, the zoœcia at the surface with the numerous mesopores and small acanthopores resemble those of *Homotrypella*, but otherwise the structure is that of *Homotrypa*.

Occurrence. Abundant in the Richmond near Osgood and near Versailles, Indiana.

Cat. Nos. 41768, 41769, U.S.N.M.

HOMOTRYPA WORTHENI var. PROMINENS, new variety.

Plate XXIV, figs. 15, 16.

The very prominent, elongated monticules will distinguish this variety. The zoarium also differs from the cylindrical branches of *H. wortheni* by forming broader, subcompressed to flat fronds. Internally this variety and species are practically identical.

Occurrence. Abundant in the highest beds of the Richmond along Elkhorn Creek near Richmond, Indiana.

Cat. No. 41767, U.S.N.M.

HOMOTRYPA AUSTINI, new species.

Plate XXIV, figs. 5–9.

The branches of this neat species are small, cylindrical, 4 to 8 mm in diameter, and divide rather frequently. Surface smooth. Zoœcia small, polygonal to rounded, thick walled, nine to ten in 2 mm. Acanthopores numerous, four or more often surrounding a zoœcium and generally visible at the surface as blunt spines. Mesopores, except an occasional one in the maculæ, wanting. The zoœcia in the axial region are without diaphragms and have thin, crinkled walls, the greatest amount of crinkling occurring just before the peripheral

region is reached. As a rule, both cystiphragms and diaphragms are absent in the peripheral region of the ordinary zoœcia, but in those of the maculæ there is an abundance of the former.

This species is named after its discoverer, Dr. George M. Austin, of Wilmington, Ohio, who, notwithstanding arduous professional duties, finds time for enthusiastically collecting and studying the fossils of that region.

Occurrence.—Abundant in the middle division of the Richmond formation at Dutch Creek, 4½ miles northwest of Wilmington, Ohio, and at Cowans Creek, 7 miles southwest of the same place.

Cat. No. 41762, U.S.N.M.

HOMOTRYPA CYLINDRICA, new species.

Plate XXII, figs. 8–13.

Zoarium ramose, branches long, cylindrical, from 4 to 15 mm. in diameter, dividing dichotomously at intervals of from 3 to 4 cm. Surface varying from smooth to tuberculated, the maculæ or monticules generally somewhat transversely elongated. Zoœcial apertures thick walled, usually angular, direct, about nine in 2 mm. Mesopores few, seldom occurring outside of the clusters. Only well-preserved examples show at the surface the numerous and very large acanthopores characteristic of the species. The walls of the zoœcia in the axial region are thin and but little crenulated, but in the mature region they become so thickened as to almost equal in breadth the diameter of the zoœcial cavity. Cystiphragms well developed. Diaphragms very few, if present at all, the structures simulating them probably being large cystiphragms.

The large and numerous acanthopores and the thickness and minute structure of the walls give a very characteristic, even bizarre, appearance to tangential sections. The number of acanthopores varies, the normal number being four to five when they are large to five to nine smaller ones around a zoœcium. In vertical sections the acanthopores are seen not only to proceed directly to the surface parallel with the zoœcial walls, but they also sometimes cross them obliquely.

Occurrence.—Richmond formation, Richmond and Versailles, Indiana, and Oxford, Ohio.

Cat. Nos. 41757–41759, U.S.N.M.

HOMOTRYPA RAMULOSA, new species.

Plate XXV, figs. 1–4.

Zoarium consisting of subcylindrical or somewhat compressed stems from which branches proceed frequently and without regularity; an average example is 8 cm. high and 8 to 12 mm. in thickness. Surface

with low broad monticules, the center of each usually occupied by a star-like cluster composed of mesopores only and surrounded by cells slightly larger than the average. Apertures polygonal, direct, ten to eleven in 2 mm. Mesopores restricted almost entirely to the clusters. Acanthopores few and rather small, although now and then one of large size may be present, and these in vertical sections have thin transverse partitions. Diaphragms are developed in the zoœcial tubes as the peripheral region is approached and are quite numerous near the surface. Cystiphragms of rather small size line the tubes as usual in the peripheral region; in a tangential section they appear much less curved than is generally the case, sometimes showing as a straight line across the cell cavity.

The small cells and much branched growth externally, and the strong development of both diaphragms and cystiphragms in the peripheral region, are characteristics which readily distinguish this form from other Richmond species.

Occurrence.—Middle division of the Richmond formation at Versailles, Indiana.

Cat. No. 41760, U.S.N.M.

HOMOTRYPA NITIDA, new species.

Plate XX, fig. 15; plate XXV, fig. 5–8.

Zoarium of small, frequently branching, more or less cylindrical stems, usually 4 or 5 mm. in diameter. Surface smooth. Maculæ large, composed of zoœcia, which are often twice the diameter of the ordinary cells; 10 zoœcia in 2 mm. Diaphragms few in the axial region, not very abundant in the peripheral region, where also the cystiphragms are large but not abundant. Acanthopores small, few, usually wanting.

This species is closely related to *H. gelasinosa*, and may be only a variety of that form. The larger maculæ and acanthopores and flabellate growth of the latter are deemed of sufficient value to distinguish it from *H. nitida*.

Occurrence.—Richmond formation, near Osgood, Indiana.

Cat. No. 41771, U.S.N.M.

HOMOTRYPA NICKLESI, new species.

Plate XXII, figs. 4–7.

In growth and external features this species resembles *H. communis* but is readily distinguished by the less robust growth and the tendency to branch more frequently. The internal structure further distinguishes the two, since *H. nicklesi* is of the *H. curvata* group, while *H. communis* is of the group to which it gives its name. Surface smooth with regularly disposed maculæ of larger cells and mesopores. Zoœcia

ith moderately thick walls, about nine in 2 mm. Acanthopores not resent at the surface and usually also absent in sections. Diaphragms bsent in the axial region, appearing in the transitional zone to the eripheral region and increasing in number toward the surface. ystiphragms in a moderately crowded series in the peripheral region.

The well-developed diaphragms and cystiphragms and the almost omplete absence of acanthopores, together with the growth and surice features, characterize this species. The specific name is in honor f Mr. John M. Nickles, who collected the species.

Occurrence.—Rather abundant in the Richmond at Raywick, Kentucky.

Cat. No. 34328, U.S.N.M.

HOMOTRYPA GELASINOSA Ulrich.

Homotrypa gelasinosa Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 411, pl. xxxii, 2–2d.

The very pronounced elongate maculæ characterize this species. In rowth and general characters it is near *H. flabellaris*, but the smaller oecia, of which there are ten in 2 mm., few acanthopores and elongate naculæ, separate it from that form. The nearest relative is probably *T. nitida*, which see for comparison.

Occurrence.—Rare in the Richmond, at Wilmington, Illinois.

Cat. No. 41770, U.S.N.M.

HOMOTRYPA SPLENDENS, new species.

Plate XXV, figs. 11–14.

Zoarium flabellate, an average example measuring 4 to 5 cm. in ieight, 3 to 4 cm. in width, and 3 to 4 mm. in thickness. Surface vith strongly elevated monticules, 2.5 to 3 mm. apart, measuring rom center to center. Apertures varying from subpolygonal to subircular, with very thick walls, about seven in 2 mm. Acanthopores pparently wanting. In the axial region the walls are very thin and he diaphragms rather numerous, averaging a little more than their liameter apart. In the peripheral region the walls are very much hickened and both cystiphragms and diaphragms are abundant.

This splendid species, with its large cells and thick walls, requires 10 detailed comparison with other forms. The associated *H. flabellaris* esembles it in zoarial growth, but the difference in the size of the ells of the two species can be seen with the unassisted eye. Sections how that a great deal of calcareous tissue is deposited along the tube valls and even on the cystiphragms. This accumulation often obscures he cystiphragms and the boundaries of the cells. The unusual thiniess of the walls in the axial region is in marked contrast with their reat thickening in the peripheral region. The apparent absence of

acanthopores in this well-developed species of *Homotrypa* is also noteworthy.

Occurrence.—Not uncommon in the Richmond formation at Wilmington, Illinois.

Cat. No. 41761, U.S.N.M.

EXPLANATION OF PLATES.

Plate XX.

Homotrypa dumosa, new species, p. 576. (See also Plate XXI, figs. 1–3.)

Fig. 1. Tangential section × 35, showing the thin walls, small acanthopores, and narrow intermural space.
Lorraine formation, Covington, Kentucky.

Retepora columnifera Busk, p. 571.

2. Tangential section of this recent chilostomatous bryozoan, showing structure of walls and parenchymal chord.

Escharopora pavonia (D'Orbigny), p. 571.

3. Vertical section × 35.
4. Tangential section × 35.
Lorraine formation, Cincinnati, Ohio.

Ceriocava ramosa D'Orbigny, p. 569.

5, 6. Vertical and tangential sections of this cyclostomatous bryozoan, showing vesicles supposed to be homologous with the cystiphragms. (After Ulrich.)
Cretaceous of France.

Homotrypa grandis, new species, p. 578.

7. Tangential section × 20.
8. Vertical section × 20, showing only a portion of the axial and peripheral regions.
9. Tangential section × 50 of a single zoœcium.
10. Natural-size view of a fragment of a zoarium.
Lorraine formation, Lumsleys Fork, 2 miles west of Goodlettsville, Davidson County, Tennessee.

Homotrypa pulchra, new species, p. 577.

11. Vertical section × 20, showing the distribution of diaphragms and cystiphragms.
12, 13. Tangential section × 20, and a small portion of same × 50.
14. A small but nearly complete zoarium, natural size.
Lorraine formation, Cincinnati, Ohio.

Homotrypa nitida, new species, p. 586. (See also Plate XXV, figs. 5–8.)

15. Tangential section of several zoœcia × 40.
Richmond formation, near Osgood, Indiana.

PLATE XXI.

Homotrypa dumosa, new species, p. 576. (See also Plate XX, fig. 1.)

Fig. 1. Fully matured region of a tangential section × 20.
2. Vertical section × 20.
3. A complete zoarium, natural size.
Lorraine formation, Covington, Kentucky.

Homotrypa cincinnatiensis, new species, p. 576.

4–6. Three nearly complete zoaria, natural size, exhibiting variations in growth.
7, 8. Tangential and vertical sections × 20.
9, 10. Tangential sections × 50 of zoœcia in the peripheral region in different stages of maturity.
Lorraine formation, Cincinnati, Ohio.

Homotrypa flabellaris var. *spinifera*, new variety, p. 580.

11. Portion of a frond, natural size.
12, 13. Nearly complete zoaria, natural size, of a narrow form of the variety.
14, 15. Vertical and tangential sections × 20.
Lorraine formation, Covington, Kentucky.

PLATE XXII.

Homotrypa libana, new species, p. 578.

Fig. 1. Vertical section × 20.
2. Tangential section × 20.
3. Tangential section of several zoœcia × 40, showing the intermural structure and the small acanthopores.
Lorraine formation, Lebanon, Ohio.

Homotrypa nicklesi, new species, p. 586.

4, 5. Vertical and tangential sections × 20.
6. Tangential section of several zoœcia × 40.
7. Natural-size view of a fragment of a zoarium.
Richmond formation, Raywick, Kentucky.

Homotrypa cylindrica, new species, p. 585.

8, 9. Tangential and vertical sections × 20, illustrating the internal characters of the species.
10. Tangential section of several zoœcia × 40, showing the intermural structure and the large acanthopores with the small central tube.
11. Vertical section × 50, exhibiting structure of walls and cystiphragms.
12, 13. Natural-size views of two nearly complete zoaria.
Richmond formation, Richmond, Indiana.

PLATE XXIII.

Homotrypa communis, new species, p. 581.

Figs. 1, 2. Tangential and vertical sections × 20.
3. Tangential section of a single zoœcium × 50, showing the characters in the fully matured region.
4. Natural size view of a small zoarium.
Richmond formation, Oregonia, Ohio.

Homotrypa nodulosa, new species, p. 582. (See also Plate XXV, fig. 15.)

Figs. 5, 6. Vertical sections × 20 and × 30, illustrating the internal characters.
7. Tangential section × 20, showing large acanthopores and few mesopores
8. Tangential section × 20, with numerous mesopores.
9–11. Three fragments, natural size.
Richmond formation, Hanover, Ohio.

Homotrypa obliqua Ulrich, p. 575.

12. Vertical section × 20.
13. Natural size view of a complete zoarium of the form found in the Fai mount beds.
14. Natural size view of the prevailing form in the Bellevue beds.
Lorraine formation, Cincinnati, Ohio.

Homotrypa curvata var. *præcipta*, new variety, p. 575.

15. Fragment of zoarium, natural size. Utica formation, West Covingto Kentucky.

PLATE XXIV.

Homotrypa richmondensis, new species, p. 582.

Fig. 1. Tangential section × 20, through the fully matured region.
2. Vertical section × 20.
3. Tangential section × 50, illustrating the structure of the walls and acanth pores.
Richmond formation, Hanover, Ohio.
4. Specimen of the natural size.
Richmond formation, Richmond, Indiana.

Homotrypa austini, new species, p. 584.

5. Tangential section × 20, showing the wide intermural spaces.
6. Vertical section × 20, illustrating the distribution of the cystiphragms.
7. Fully matured condition of a single zoœcium × 50.
8, 9. Fragments of zoarium, natural size.
Richmond formation, Dutch Creek, near Wilmington, Ohio.

Homotrypa wortheni (James), p. 583.

10. Vertical section × 20.
11, 12. Tangential sections × 50 and × 20, illustrating the characters of the matu region, the latter showing communication pores.
13, 14. Fragments of zoaria, natural size, showing variations in size and surfa characters.
Richmond formation, Richmond, Indiana.

Homotrypa wortheni var. *prominens*, new variety, p. 584.

15, 16. Natural size views of two fragments. Richmond formation, Elkho Creek near Richmond, Indiana.

Homotrypa wortheni var. *intercellata*, new variety, p. 584.

17. Tangential section × 35, through mature region. Richmond formatic near Osgood, Indiana.

PLATE XXV.

Homotrypa ramulosa, new species, p. 585.

Figs. 1, 2. Vertical and tangential sections × 20, illustrating the internal characters.
3. Tangential section × 50, through fully matured region of several zoœcia.
4. Natural size view of a nearly complete zoarium.
Richmond formation, Versailles, Indiana.

Homotrypa nitida, new species, p. 586. (See also Plate XX, fig. 15.)

5. Tangential section × 20.
6. Vertical section × 20, showing form and distribution of cystiphragms and diaphragms.
7, 8. Natural size views of fragments.
Richmond formation, near Osgood, Indiana.

Homotrypa dawsoni (Nicholson), p. 581.

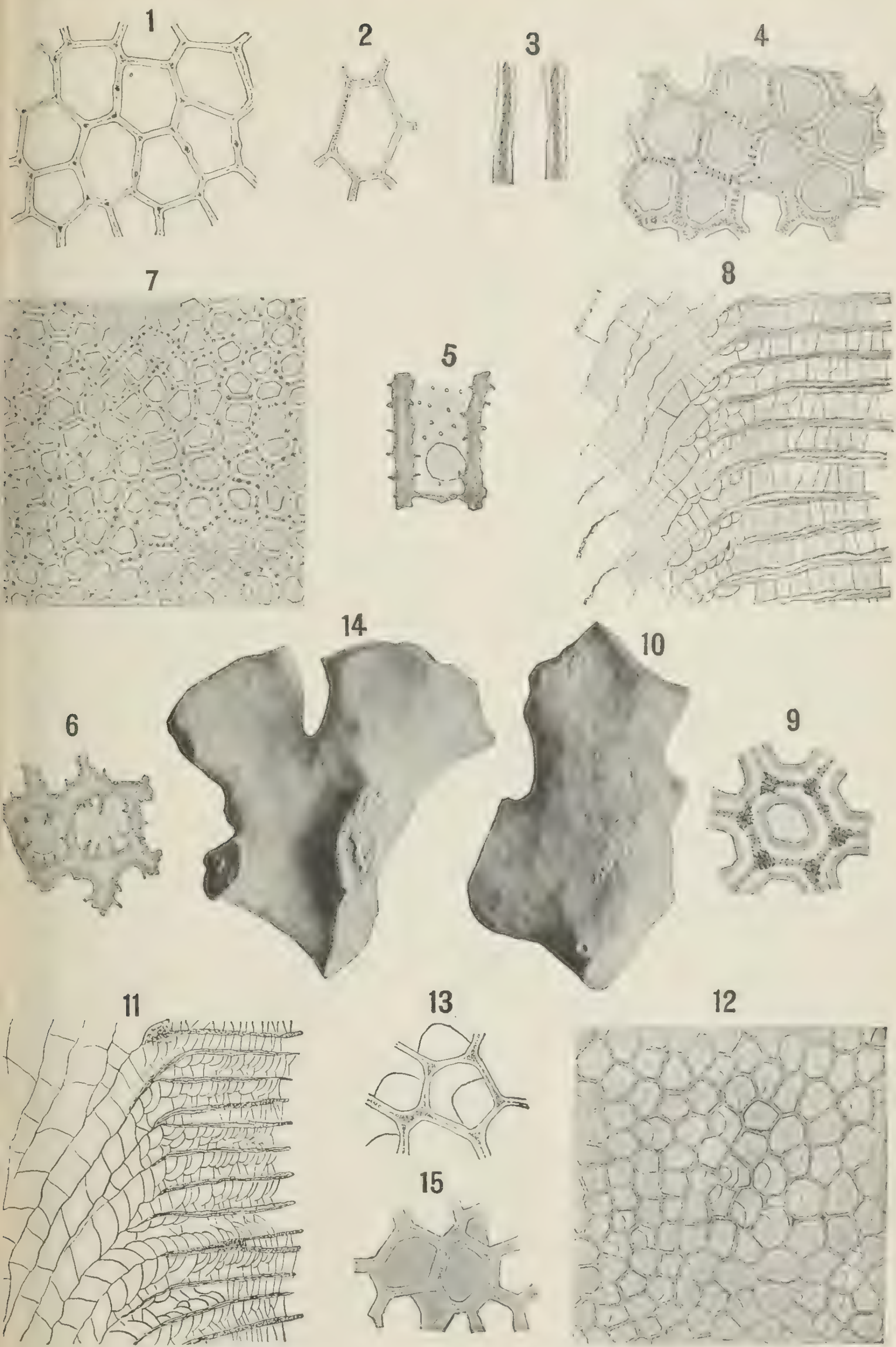
9. Vertical section × 20, showing distribution of cystiphragms.
10. Tangential section × 20, through fully matured region.
Richmond formation, Waynesville, Ohio.

Homotrypa splendens, new species, p. 587.

11, 12. Vertical and tangential sections × 20, illustrating the internal characters of the species.
13. A single zoœcium × 50, as seen in tangential section.
14. Natural size view of a fragment of a frond of this species.
Richmond formation, Wilmington, Illinois.

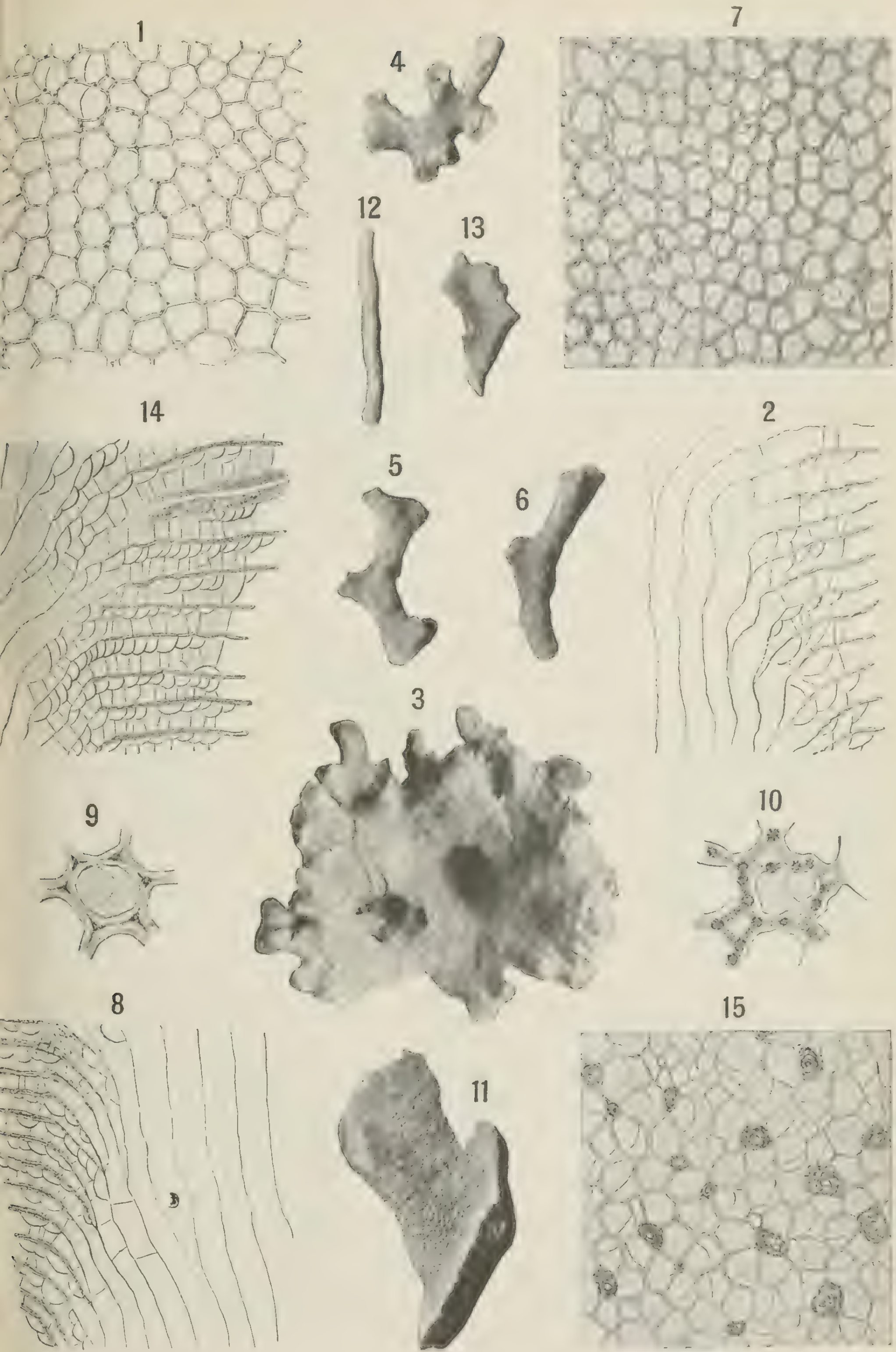
Homotrypa nodulosa, new species, p. 582. (See also Plate XXIII, figs. 5–11.)

15. Tangential section of a single zoœcium × 35, showing communication pores. Richmond formation, Hanover, Ohio.



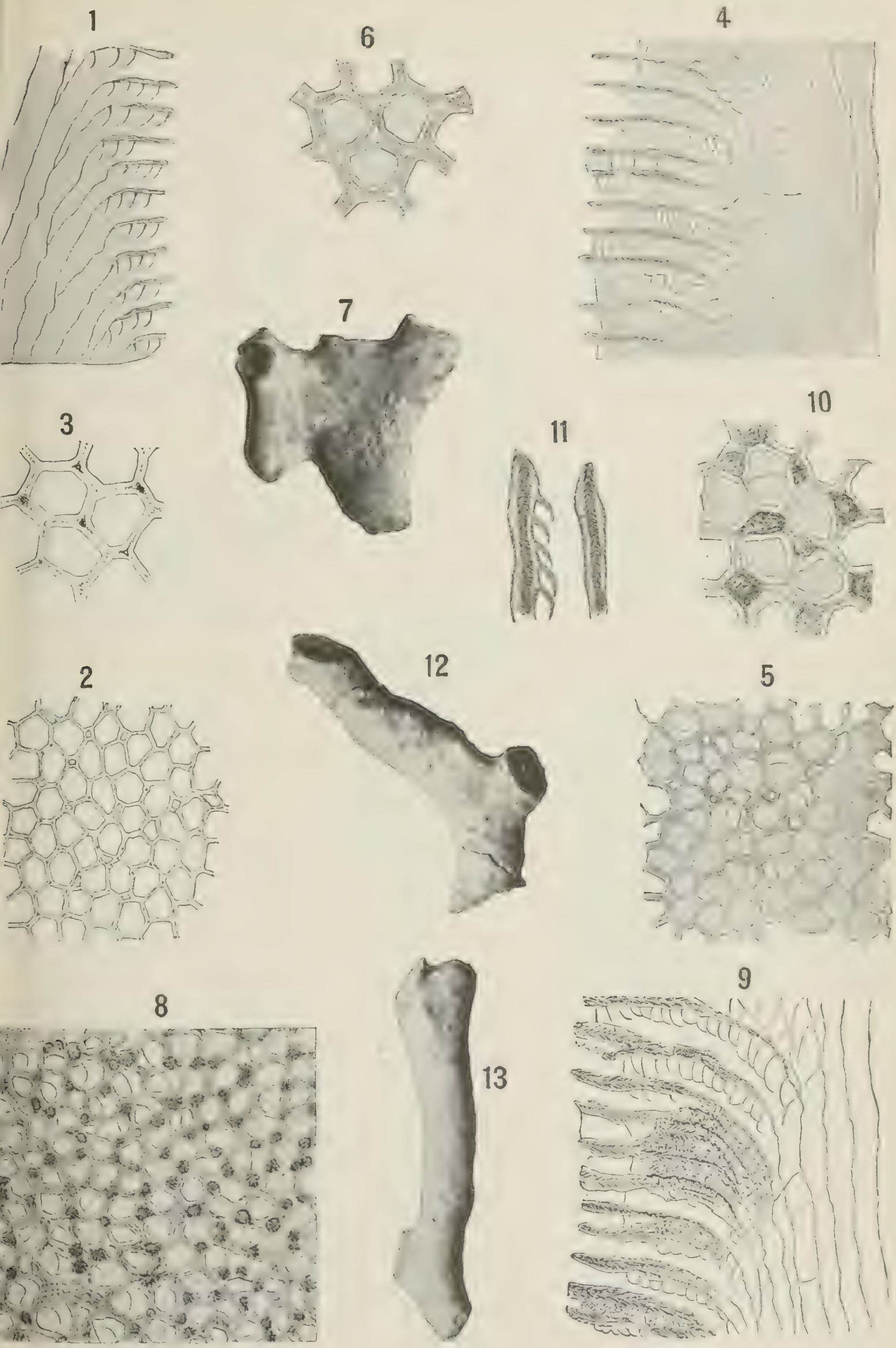
CINCINNATIAN SPECIES OF HOMOTRYPA.

FOR EXPLANATION OF PLATE SEE PAGE 588.



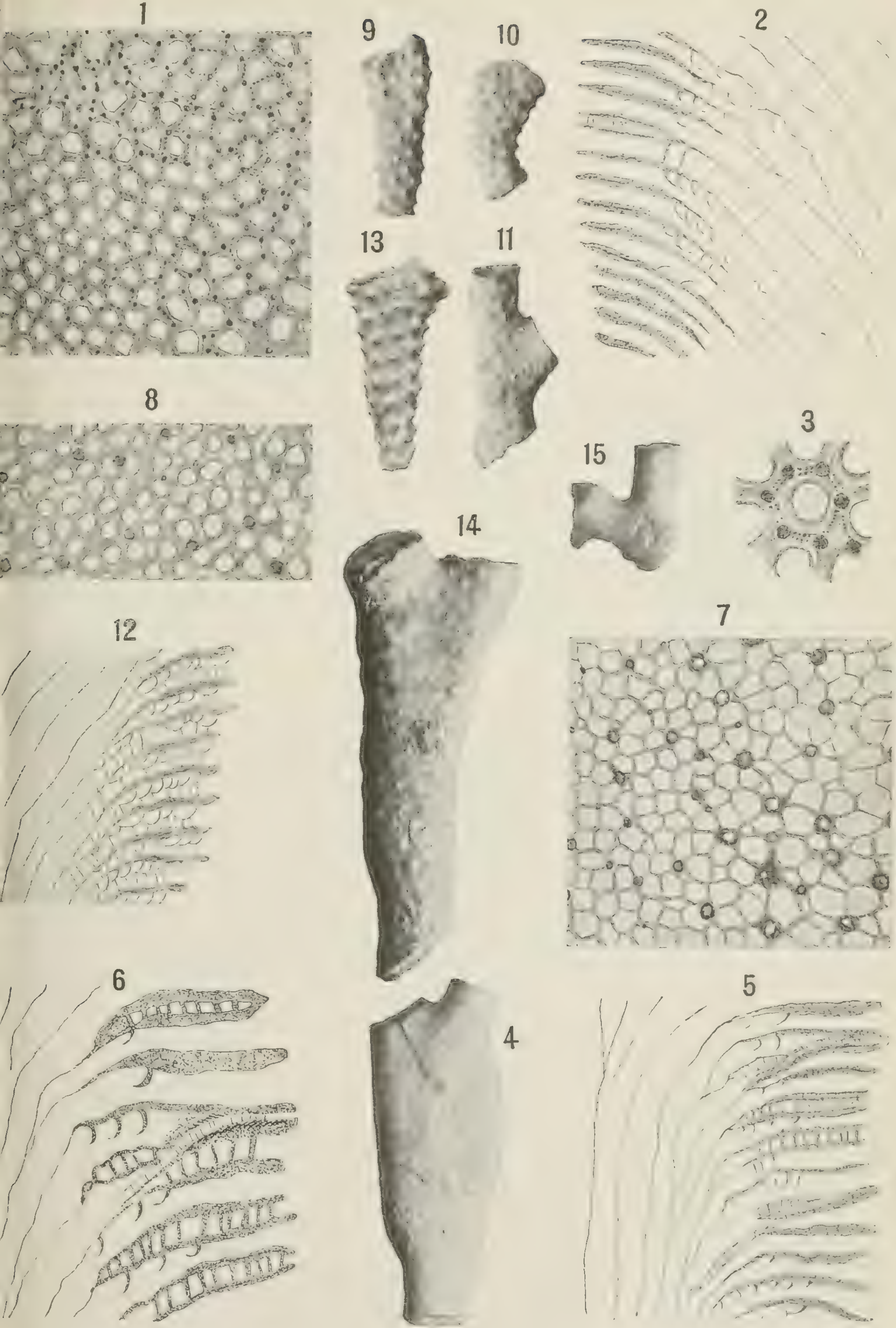
CINCINNATIAN SPECIES OF HOMOTRYPA.

FOR EXPLANATION OF PLATE SEE PAGE 589.



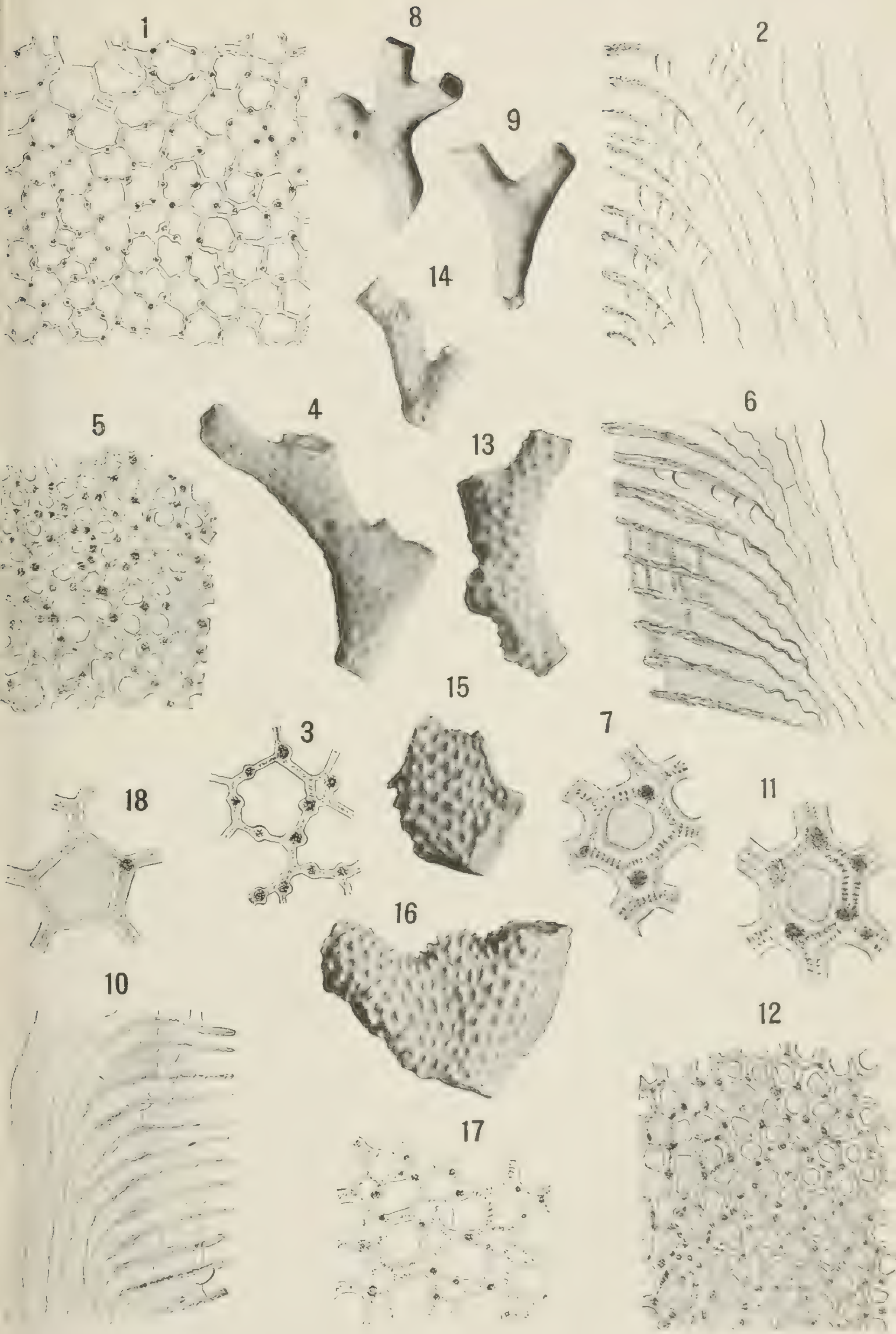
CINCINNATIAN SPECIES OF HOMOTRYPA.

FOR EXPLANATION OF PLATE SEE PAGE 589.



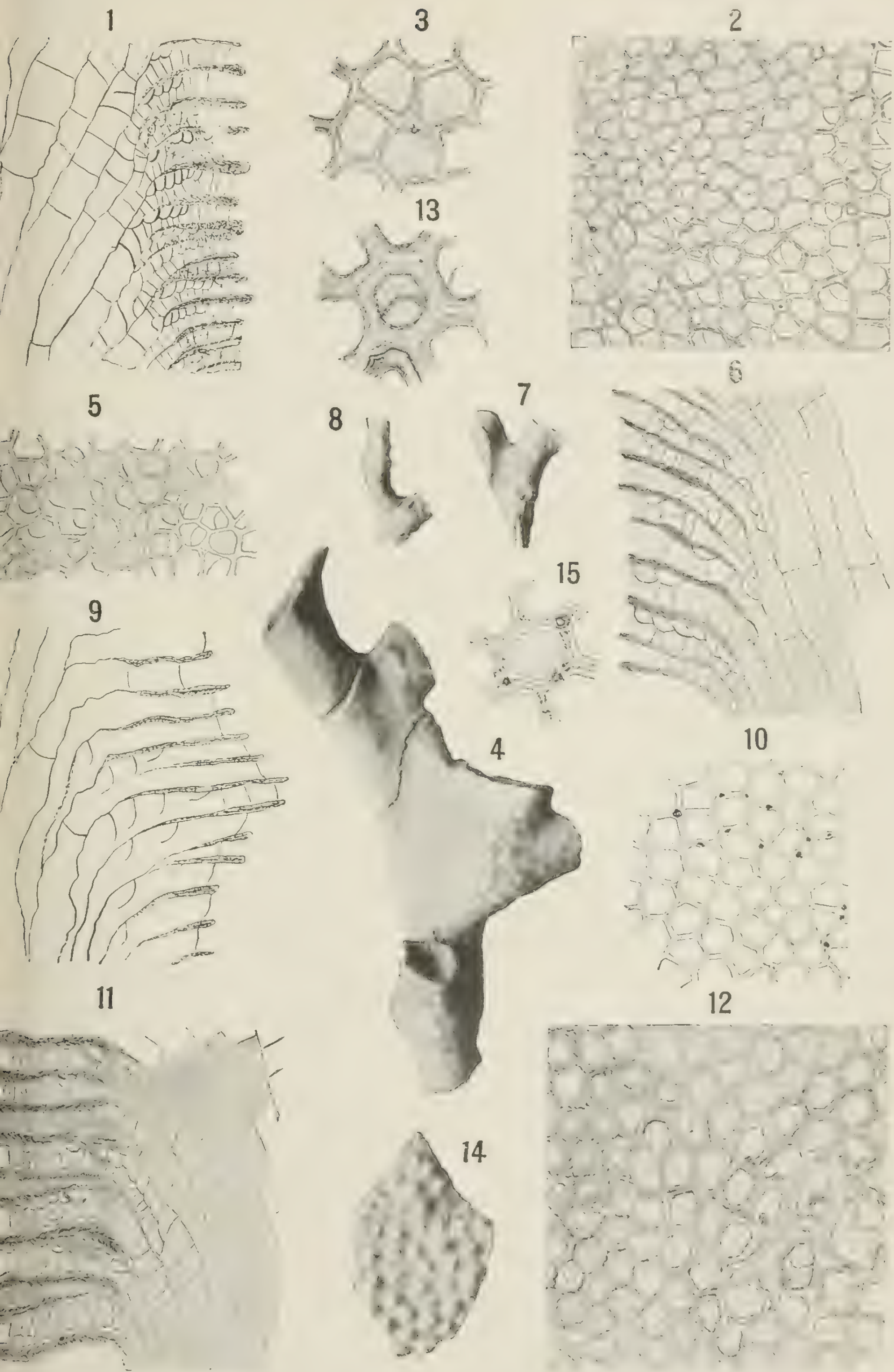
CINCINNATIAN SPECIES OF HOMOTRYPA.

FOR EXPLANATION OF PLATE SEE PAGES 589-590.



CINCINNATIAN SPECIES OF HOMOTRYPA.

FOR EXPLANATION OF PLATE SEE PAGE 590.



CINCINNATIAN SPECIES OF HOMOTRYPA.

FOR EXPLANATION OF PLATE SEE PAGE 591.

A REVIEW OF THE ELASMOBRANCHIATE FISHES OF JAPAN.

By David Starr Jordan and Henry W. Fowler,
Of the Leland Stanford Junior University.

In the present paper is given a record of the species of Elasmobranchiate fishes, sharks, rays, and chimæras, known to inhabit the waters of Japan. It is based on the collections made by Messrs. Jordan and Snyder during the summer of 1900, and on the material contained in the Japanese museums and in the United States National Museum, some of which were collected by the U. S. Fish Commission Steamer *Albatross*. The accompanying figures are chiefly by Mr. William Sackston Atkinson.

Subclass SELACHII.

This includes among recent fishes the sharks and the rays, marine fishes mostly of large size, abounding in all seas.

We begin the group with the archaic type, the order or suborder Notidani, proceeding thence from the more generalized sharks to the specialized skates. The true sharks form an almost perfect gradation into the skates, but there are no forms extant which connect the Notidani with modern sharks.

(σέλαχος, shark; the word originally meaning cartilage.)

ORDERS OF SELACHII IN JAPAN.

a. Gill-openings 6 or 7; dorsal fin single; vertebral column imperfectly segmented, each segment being equivalent to 2 vertebræ, and bearing 2 neural arches; anal fin present .... NOTIDANI, I.

aa. Gill-openings 5; vertebral column well segmented, each segment forming a neural arch and 1 centrum.

b. Vertebræ each with the internal calcareous lamellæ radiating from the central ring; anal fin present .... ASTEROSPONDYLI, II.

bb. Vertebræ with the internal calcareous lamellæ not radiating, but arranged in one or more concentric circles or series around the central ring; no anal fin; palatoquadrate arch not articulated to the skull.

c. Gill-openings lateral; dorsal fins 2 .... TECTOSPONDYLI, III.

cc. Gill-openings ventral; dorsal fins small and posterior, or wanting; body and pectoral fins forming a depressed disk .... BATOIDEI, IV.

Order I. NOTIDANI.

Sharks with the branchial apertures in increased number, 6 or 7; only one dorsal fin. Vertebral column imperfectly segmented so that from each segment 2 neural arches and 2 vertebral bodies arise. Among existing sharks this group contains 2 families. Numerous genera represented by fossils seem allied to these and to the Cestraciont types.

(*Notidanus*, νωτιδανός, dry back, the Greek name of some shark, in Athenæus.)

a. Palatoquadrate apparatus articulated with the postorbital processes of the skull; body moderately elongate; teeth in the two jaws unlike; mouth inferior. HEXANCHIDÆ, I.

aa. Palatoquadrate apparatus not connected with the skull; body greatly elongate, almost eel-shaped; dorsal, anal, and ventrals close together on posterior part of body; teeth in the two jaws alike; mouth anterior..CHLAMYDOSELACHIDÆ, II.

Family I. HEXANCHIDÆ.

Body moderately elongate, somewhat depressed anteriorly, tapering toward the caudal fin. Head depressed, oblong, with the snout projecting. Eyes submedian or anterior, without nictitating membrane. Mouth subinferior, large, arched in front; no labial fold. Teeth in the two jaws unlike; in the upper jaw 1 or 2 pairs of awl-shaped teeth, the next six teeth broader and each provided with several cusps, one of which is much the strongest. Lower jaw with 6 large comb-like teeth on each side, besides the smaller posterior teeth. Spiracles small, on the side of the neck. Only one dorsal fin, without spine, opposite the anal, and similar to it. No pit at the root of the caudal. Gill-openings wide, 6 or 7 in number. Viviparous sharks, sometimes reaching a very large size. Species of the warm seas.

a. Gill-openings, 7 on each side ....*Heptranchias*, 1.

1. HEPTRANCHIAS Rafinesque.

Heptranchias RAFINESQUE, Caratteri, 1810, p. 14 (*cinereus*).
Notorhynchus AYRES, Proc. Cal. Acad. Sci., I, 1856, p. 72 (*maculatus*).
Heptanchus of AUTHORS.

Gill-openings 7 on each side. Lower teeth uniform in size or decreasing toward corners of mouth; cusps on the cutting edge more or less regularly graduated.

(ἕπτα, seven; βράγχια, gills.)

a. NOTORHYNCHUS. Median tooth of lower jaw with the central cusp small or wanting.
b. Color, gray; cusps of most teeth growing smaller from the second .....*deani*, 1.

1. HEPTRANCHIAS DEANI Jordan and Starks.

ABURAZAME (FAT SHARK).

Heptranchias deani Jordan and Starks, Proc. Cal. Acad. Sci., 1901, L, p. 348; Misaki.

Head, 6 in length; width of body at pectorals, $1\frac{1}{3}$ in head; eye about $4\frac{1}{2}$; snout about $3\frac{1}{2}$; width of mouth at corners, $2\frac{1}{3}$; pectorals, $1\frac{1}{2}$; base of ventrals, 2; depth of caudal peduncle, $4\frac{1}{4}$ in head.

Body very elongate, more or less rounded, though somewhat depressed in front; tail compressed, elongate, tapering. Head elongate, pointed, compressed, broader than deep; snout produced, compressed above, flat, roundly pointed; eye large, anterior, lateral, superior; mouth large, triangular, narrowly rounded in front; symphysis of mandible a little before eye, which is over anterior part of mouth; lips not especially thick; corners of mouth forming a long groove equal to one-half length of exposed dental margin of mandible; teeth in upper jaw sharp, long, pointed, hooked backward, without lateral cusps; a median tooth at symphysis of mandible with two or three small cusps on each side; teeth in mandible 4 on each ramus, each tooth with a serrated cutting edge composed of 6 or more cusps; first cusp with a very small notch in front, second enlarged, and all arranged in the formula 1+1+3+1, 1+1+4+1, 1+1+5+1, 1+1+6+1, according to individual size; while the cutting edge is continuous it is not uniform and even, as depth of each tooth is a little less behind, edge above a trifle oblique; inner buccal fold in mandible thick and fleshy; tongue not free from floor of mouth; nostrils large, about midway on snout below, between its tip and front of eye; interorbital width convexly flattened. Spiracles small, superior, and about midway between eye behind and gill-opening. Gill-openings large, broad, becoming progressively smaller behind, all entirely in front of root of pectoral. Body very finely roughened.

Dorsal fin small, its greater portion before origin of the anal; anal low, its base long; pectorals small, edges posteriorly slightly emarginate; ventrals low, base long, origin nearer origin of anal than origin of pectoral; caudal very long, lower lobe deep in front, then very narrow till near end, where a terminal notch is formed. Caudal peduncle compressed, somewhat triangular in cross section, flattened above.

Color in spirits dark gray brown above and on the upper parts of fins, below pale or whitish; in a photograph in the Imperial University a few whitish spots are shown.

Length $38\frac{5}{8}$ inches (98 cm. 3 mm.).

This description from the original type, a female, No. 12620, ichthyological collections, Leland Stanford Junior University Museum. It

was taken at Misaki by Kumakichi Aoki, with hook and line, in deep water.

The species is not rare on the coast of southern Japan.

(Named for Bashford Dean.)

Family II. CHLAMYDOSELACHIDÆ.

FRILLED SHARKS.

Body very elongate and slender, the tail tapering to a point. Head very broad and depressed. Snout broad. Eyes lateral and without nictitating membrane. Nostrils large, the nasal cavity separate from the mouth. Mouth anterior, the jaws almost equal. Teeth in oblique rows, the bases extended backward, and the cusps slender. Spiracles present. Gill-openings six. Dorsal fin posterior, without spine; anal fin well developed. No pit at root of caudal. First gill-membrane not free across the isthmus, but joined by median and rather thick membrane. Intestine said to have a spiral valve. Anterior basibranchial cartilages present.

2. CHLAMYDOSELACHUS Garman.

Chlamydoselachus GARMAN, Bull. Essex Inst., Jan. 17, 1884, p. 47 (*anguineus*).
Chlamydoselache GÜNTHER (variant in spelling).

Opercular flap forming a broad frill over first gill-opening. Eyes rather small; mouth very large, extending far beyond the eye. Teeth similar in the jaws, each with three slender, curved, subconical cusps, separated by a pair of rudimentary denticles, on a broad base; no median series of teeth above like that on the symphysis of the mandible. Mouth larger than broad, and with no labial folds at angles. Pupil horizontally elongated. Fins broad, rounded; caudal without a notch.

Of this genus but a single living species is known. It inhabits the open sea in waters of some depth, and is most abundant in the Kuro Shiwo or warm current on the east coast of Japan.

(χλαμύς, mantle or frill; σέλαχος, shark.)

2. CHLAMYDOSELACHUS ANGUINEUS Garman.

RABUKA; KAGURAZAME (SCAFFOLD SHARK).

Chlamydoselachus anguineus GARMAN, Bull. Essex Inst., Jan. 17, 1884, p. 47, with figs.; Japanese seas; Bull. Mus. Comp. Zool., 1885, XII, No. 1, with plates and account of anatomy; off Japan.—GÜNTHER, Deep Sea Fishes Challenger, 1884, p. 2, with plates; Japan.—COLLETT, Bull. Soc. Zool. France, 1890, p. 219; Funchal, Madeira.—JORDAN and EVERMANN, Fish N. M. America, I, 1896, p. 15 (after Garman).

Head about $7\frac{1}{2}$ in length; depth about $12\frac{2}{3}$; tail $1\frac{1}{6}$ in trunk and head; eye $8\frac{1}{5}$ in head; snout 4; maxillary $1\frac{2}{3}$; interorbital space $2\frac{1}{4}$; width of

mouth at corners $2\frac{1}{3}$; internasal space $3\frac{2}{3}$; pectoral $1\frac{1}{2}$; internasal space $1\frac{2}{3}$ in interorbital space.

Body very elongate and tail greatly compressed, roughened, and tapering to a point. Head rather small, oblong, greatly depressed, broad, and its greatest depth two-thirds its width; snout depressed, broadly rounded, and projecting but little beyond mandible; eye small, its posterior margin about first two-fifteenths of length of head; nostrils large, lateral, on sides of snout and a little low in position; mouth very large, more than half the head; teeth tricuspid, spaces between each cusp with a small denticle at base, similar in both jaws, and in formula $\frac{13-0-13}{11-1-11}$; well separated, in oblique rows, with not more than 6 teeth in each row; tongue small, slightly elongate, point rounded, and a little free in front; inside of mouth roughened, especially the tongue. Gill-openings very large, first the largest, the others progressively smaller; inner edges of branchial arches roughened; gill-filaments flattened, adnate to interbranchial septa except at tip; pharynx long and broad; gill-membrane joined to isthmus medially by a thick membrane.

Scales very small and sharp, a little enlarged along lateral line, most of edges of fins, and jaws, becoming especially large at angle of the latter.

Dorsal small, its origin about over that of anal; anal about twice as large as dorsal; pectoral small, broad, with a very blunt angle; ventrals large, broad, and rounded; caudal with broad lower lobe, tapering to an elongate and sharp point, upper rays very short and uniform.

Color in spirits uniform brown.

Length $39\frac{1}{8}$ inches (99 cm. 6 mm.).

This description from a Misaki specimen.

Kuro Shiwo, off Izu, Sagami, and Awa, on the east coast of Japan; our three specimens from off Misaki, in Sagami. It has also been taken off Madeira and off Norway in deep water, and it is probably widely distributed.

Our largest example measures $59\frac{1}{4}$ inches (148 cm. 6 mm.).

(*anguineus*, from *anguis*, the slow worm, the word allied to *Anguilla* = ἔγχελυς, eel.)

Order II. ASTEROSPONDYLI.

TYPICAL SHARKS.

The essential character of this order is in the structure of the vertebræ. The calcareous lamellæ within each vertebra radiate from the central ring. The group contains the great body of living sharks, including all of those with 5 gill openings, 2 dorsals, and an anal fin.

(ἀστήρ, star; σπόνδυλος, vertebra.)

FAMILIES OF ASTEROSPONDYLI.

I. CESTRACIONTES. Palatoquadrate apparatus articulated to preorbital part of skull; dorsal fins with spines; head short and blunt; teeth of differing forms in the same individual .... HETERODONTIDÆ, III.

II. GALEI. Palatoquadrate apparatus not articulated with skull; no dorsal spines; head more or less pointed in profile; teeth not differing widely in form in the same individual.

a. First dorsal fin over or behind ventrals; spiracle present; no nictitating membrane.

b. Tail not bent upward; nostrils not confluent with the mouth.

c. Sharks oviparous .... SCYLIORHINIDÆ, IV.

cc. Sharks ovoviviparous .... HEMISCYLLIIDÆ, V.

aa. First dorsal fin inserted more or less in advance of ventrals.

d. First dorsal fin high, highest anteriorly, its base wholly in front of that of ventrals.

e. Caudal fin not lunate, its upper lobe two or more times length of lower, with a notch below toward its tip; side of tail not keeled.

f. Last gill-opening above base of pectoral.

g. Tail moderately developed, forming less than one-third of the total length; eyes with nictitating membranes.

h. Head normally formed .... CARCHARIIDÆ, VI.

hh. Head hammer-shaped or kidney-shaped by the extension of its sides .... SPHYRNIDÆ, VII.

gg. Tail exceedingly long, forming about one-half the total length; eyes without nictitating membrane .... ALOPIIDÆ, VIII.

ff. Last gill-opening entirely in front of pectoral; snout ending in a long flat blade .... MITSUKURINIDÆ, IX.

ee. Caudal fin lunate; caudal peduncle with a keel on each side; size large.

i. Last gill-opening entirely in front of pectorals.

j. Gill-openings moderate; teeth large and sharp ..LAMNIDÆ, X.

jj. Gill-openings very wide, nearly meeting under throat; teeth very small and numerous; size enormous. CETORHINIDÆ, XI.

ii. Last gill-opening above base of pectorals; teeth small; size large .... RHINODONTIDÆ, XII.

Family III. HETERODONTIDÆ.

CESTRACIONT SHARKS.

Body elongate; obtusely trihedral, gradually tapering backward; head high, with the forehead declivous, and little prominent. Mouth rather narrow, the upper lip divided into 7 lobes, the lower with a fold; dentition similar in both jaws, small obtuse teeth in front, and the lateral teeth molar-like and enlarged. Nostrils confluent with the mouth. Gill openings 5. Spiracles small. Dorsal fins 2, and each provided with a strong spine. Caudal fin usually notched at tip. Oviparous, the egg-cases very large, subconical, without tentacles, and spirally twisted. Small sharks now inhabiting the Pacific Ocean. Species supposed to belong to the same family are widely distributed as fossils in the Mesozoic and earlier periods.

3. HETERODONTUS Blainville.

Heterodontus BLAINVILLE, Nouv. Bull. Scien., 1816, p. 121 (*philippi*).
Cestracion CUVIER, Règné Animal, 1st ed., 1817, p. 129 (*philippi*).
Gyropleurodus GILL, Proc. Acad. Nat. Sci. Phila., 1862, p. 489 (*francisci*).
Tropidodus GILL, Proc. Acad. Nat. Sci. Phila., 1862, p. 489 (*pantherinus*).

Body elongate, thick and heavy anteriorly, and the tail tapering. Head thick, oblong, broad. Snout bluntly rounded, rather long, and protruding. Eyes small, high, with the ridges above more or less prominent. No nictitating membrane. Mouth rather small and narrow; teeth small and obtuse in front, in the young pointed, and provided with 3 to 5 cusps; the posterior teeth molar-like, twice as broad as long, and arranged in oblique series, one series being formed by much larger teeth than those in the other series. Spiracles small, a short distance from the lower part of the eye. Gill-openings rather narrow. Scales small, sometimes cruciform. First dorsal opposite the space between pectorals and ventrals; second dorsal in advance of anal; pectorals very large and below gill-openings; caudal fin moderate, more or less bent upward. Species about 5, and usually placed in one genus, *Heterodontus*, often called by the later name of *Cestracion*. (ἑτερός, differing: ὀδούς, tooth.)

3. HETERODONTUS JAPONICUS (Duméril).

NEKOZAME (CAT SHARK).

Heterodontus philippi var. *japonica* DUMÉRIL, Hist. Nat. Poiss., I, 1870, p. 424; Japan.
Cestracion japonicus MIKLOUHO-MACLAY and MACLEAY, Proc. Linn. Soc. N. S. Wales, VIII, p. 428, pl. XX; Japan.—ISHIKAWA, Prel. Cat., 1897, p. 61; Tokyo.
Heterodontus japonicus STEINDACHNER, Reise Aurora, 1898, p. 224; Kobe.
Heterodontus zebra BLEEKER, Verh. Bat. Gen., XXVI, 1854, p. 127; Nagasaki (not of Gray).

Head $6\frac{1}{5}$; depth $6\frac{1}{2}$ in length; width of body at pectorals $1\frac{1}{5}$ in head; eye $5\frac{1}{3}$; snout $1\frac{4}{5}$; mouth about 3; interorbital space 2; width of mouth $1\frac{2}{3}$; ventrals $1\frac{1}{2}$.

Body elongate, thick, heavy, compressed anteriorly; tail rounded, tapering backward. Head broader than deep, oblong, elevated above; snout very blunt, flattened above, much longer than interorbital space; cheeks rounded, convex, full, swollen; eye very full, elongated horizontally, high, and nearer gill-opening than tip of snout; snout protrudes so that mouth is not terminal; teeth tricuspid in front, median cusp largest, but posteriorly becoming molar-like, rounded and large; lips very thick, fleshy, with a deep fold at corners of mouth; nostrils large and confluent with mouth; interorbital space broad, concave, and superorbital ridges elevated on both sides. Spiracles very distinct, a short distance below posterior margin of eye. Gill-openings in front

at first, then rising above base of pectoral, first largest, equal to $1\frac{1}{2}$ in the interorbital space, the others progressively smaller to last, which is one-half the length of first.

Body rough on the top of head and back. Fins large, first and second dorsal each with a strong, sharp-pointed spine, the origin of first midway between tip of snout and origin of the second dorsal; first dorsal higher than second, its margin concave and its height a little less than head; second dorsal with its origin midway between origin of first dorsal and tip of caudal, low, and with its margin also concave; anal smallest fin, posterior to second dorsal; pectorals very large, equal to caudal, broad and with margin straight; origin of ventral nearer first dorsal than second dorsal, short, blunt behind, and margin straight; caudal with lower lobe broad. Caudal peduncle long, compressed, flattened above and below, its least depth equal to its breadth a trifle more than eye or about $2\frac{1}{2}$ in interorbital space.

Color in spirits pale brown, dark above; across snout a broad pale bar, then one behind eye, crosswise, above, two narrow pale bars between eye and first dorsal, then two more from first dorsal, two more between first and second dorsal, two from second dorsal, a broad pale one on middle of caudal peduncle, and then another at junction of caudal and caudal peduncle; pectorals and ventrals pale above.

Length $19\frac{1}{8}$ inches (48 cm. 5 mm.).

Described from a specimen from Nagasaki.

Coasts of Japan; generally common southward. Our specimens taken at Misaki, Tokyo, Wakanoura, Kobe, Hakata, and Nagasaki. It is close to the Australian *Heterodontus philippi*, differing at least in the coloration. To the Chinese species *Heterodontus zebra*[a] it is still nearer, but according to Steindachner it differs in coloration, in the form of the head, and of the individual fins.

Family IV. SCYLIORHINIDÆ.

CAT SHARKS.

Dorsal fins 2, both rather small, without spines, the first more or less behind the ventrals; anal fin present, usually before the second dorsal; caudal fin rather long, usually with a basal lobe; the tail not keeled and not bent upward. Spiracles present, close behind eye; no nictitating membrane; gill openings small, the last one above the root of the pectorals. Mouth usually broad, with small teeth, several series being in function; teeth small, each with a median cusp and 1 to 4 small cusps on each side; nostrils near mouth, not confluent with it, sometimes provided with cirri. Gill openings 5, nearly equidistant. Mucous pores about head numerous, especially on lower side of snout. Oviparous. Egg cases large, quadrate, with prehensile tubes at the angles. Small sharks, the species rather numerous in warm seas.

[a] *Cestracion zebra* Gray, Zool Miscel., 1831, p. 5; Canton.

a. SCYLIORHININÆ. Nasal and buccal cavities separate; spiracles close behind eye; gill openings nearly equidistant; teeth small, usually tricuspid.

b. Nostrils separated from each other by a broad isthmus.

c. Scales on upper margin of the tail little if at all enlarged, usually similar to those on rest of body, or at any rate not forming a serrated edge.

d. Head not very broad; stomach not inflatable; second dorsal behind anal, which is far from caudal .... *Halælurus*, 4.

dd. Head extremely broad; stomach capable of great inflation; second dorsal over anal .... *Cephaloscyllium*, 5.

4. HALÆLURUS Gill.

Halælurus GILL, Ann. Lyc. Nat. Hist. N. Y., 1861, p. 407 (*bürgeri*).

Body and head slender; spiracle small, close behind eye; nasal and buccal cavities separate; nasal valves simple, without lobe or groove, the nostrils separated by a broad interspace; teeth small, tricuspid. First dorsal behind ventrals, second dorsal behind anal, which is far from caudal.

Very small spotted sharks, allied to *Scyliorhinus* and *Catulus*.

(ἅλς, sea; αἴλουρός, cat.)

4. HALÆLURUS BURGERI (Müller and Henle).

Scyllium burgeri MÜLLER and HENLE, Plagiost., 1837, p. 8, pl. II; Nagasaki.—SCHLEGEL, Fauna Japonica, Poiss., 1850, p. 301; Nagasaki.—BLEEKER, Act. Soc. Sci. Ind. Neerl., I, 1856, Amboyna, p. 69; Amboyna.—GÜNTHER, Cat. Fish Brit. Mus., VIII, 1870, p. 404; Japan, Formosa, Amboyna.—DUMÉRIL, Hist. Nat. Piss., I, 1870, p. 320; Nagasaki.

Halælurus burgeri GILL, Am. Lyc. Nat. Hist. N. Y., 1861, p. 407.

Head $7\frac{2}{3}$; depth about $12\frac{1}{2}$ in length; width of head $1\frac{1}{6}$ in its length; snout $2\frac{1}{2}$ in head; interorbital space $2\frac{1}{2}$; width of mouth about 2; eye 4; eye $1\frac{3}{5}$ in snout; $1\frac{3}{5}$ in interorbital space; pectoral $1\frac{1}{4}$ in head; base of anal 2.

Body very elongate, depressed somewhat in front, and tail long and tapering. Head small, rather broad, but not as broad as long, and depressed above; snout depressed, produced, lateral profile pointed, but when seen from above, broadly rounded; eyes rather large, lateral, about in center of length of head; mouth very broad, mandible beginning in front of eye, and corners below posterior part of eye; teeth small, numerous, tricuspid in both jaws; nostrils rather large, nearer eye than tip of snout, but not confluent with mouth; interorbital space broad and flattened like top of head and snout. Spiracles large and directly behind the eye at a very short distance. Gill-openings small, lateral, and above base of pectorals.

Body very finely roughened.

First dorsal much larger than second, its origin much nearer base of lower caudal lobe in front than tip of snout, and behind ventrals; second dorsal entirely behind anal and distant from first dorsal 3 times

the latter's base; anal small, low, its origin a little nearer origin of ventrals than origin of lower caudal lobe; pectorals larger than other fins, broad, and with their margin nearly straight; ventrals rather long; caudal equal to space between origin of its lower lobe, which is not very deep.

Color light brown, a trifle darker above; small round black spots irregularly grouped in double rows over back, on the sides, and between them more or less of a warmer tint; lower parts pale, immaculate, except on tail, where there are one or two dark spots; spots on caudal small.

Total length $15\frac{1}{2}$ inches (39 cm., 4 mm.).

This description is from a dried skin taken at Nagasaki by M. Yahiro.

Coast of Japan and southward, not common; seen at Misaki and Nagasaki.

(Named for M. Burger, who collected specimens and paintings about Nagasaki for Temminck and Schlegel.)

5. CEPHALOSCYLLIUM Gill.

Cephaloscyllium GILL, Am. Lyc. Nat. Hist. N. Y., 1861, p. 407 (*laticeps*).

This genus differs from *Catulus* in the very broad head, and in the power or habit of inflating the stomach when disturbed.

(*κεφαλή*, head: *Scyllium*.)

5. CEPHALOSCYLLIUM UMBRATILE Jordan and Fowler, new species.

NANUKAZAMI (SEVEN DAY SHARK); OSEIBUKA (CROWD SHARK).

Cephaloscyllium laticeps NYSTROM, Kong. Svensk Vet. Ak., 1887, p. 49; Nagasaki—ISHIKAWA, Prel Cat., 1897, p. 62; Tokyo (not *Scyllium laticeps* Duméril, which is an Australian species).

Head $6\frac{1}{5}$ in length; depth about 8; depth of head $1\frac{1}{3}$ in its length; snout $2\frac{2}{3}$ in head; interorbital space 2; width of mouth about 2; eye $3\frac{1}{3}$ in interorbital space; mouth 2 in head; pectoral $1\frac{1}{4}$; depth of caudal peduncle about 3 in interorbital space.

Body elongate, more or less depressed anteriorily, tail narrow, tapering downward. Head rather large, broad, its breadth a little less than length; snout produced, bluntly rounded, flattened above; eye small, lateral, nearer tip of snout than first gill-opening; mouth large, rather broad; teeth small, numerous, tricuspid; nostrils nearer tip of snout than eye, not confluent with mouth; interorbital space broad, flat; spiracles small, behind eye, and a little below, or for space less than diameter of the eye; gill-openings 5, posterior smallest, and a little above base of pectoral.

Scales small, rough.

First dorsal much larger than second, behind ventrals; space between it and second dorsal much greater than base of first dorsal; origin of

second dorsal nearer first dorsal than base of caudal lobe; anal fin below, and a trifle in front of second dorsal; pectorals large, nearer tip of snout than origin of ventrals; ventrals rather low, their origin nearer origin of anal than that of pectoral; caudal longer than head.

Color pale brown, very light below, marbled above with shades of dark and deep brown; on back five broad cross bars of pale ruddy brown, with blotches of darker brown, first behind the eye, next over base of pectoral, next between it and first dorsal where another is, and finally last at second dorsal; on caudal, two broad cross bars, one at base of caudal, the other near its tip. Length 38½ inches (98 cm).

Type a dried skin, No. 12693 Ichthyological collections, Stanford University Zoological Museum.

Locality, Nagasaki.

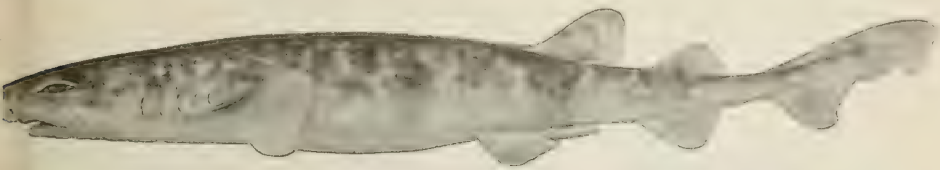


FIG. 1.—CEPHALOSCYLLIUM UMBRATILE.

Coast of Japan southward, apparently quite rare, as we have obtained only one specimen from Nagasaki, collected by Mr. Yahiro. From the same locality it is also recorded by Nystrom.

(*umbratilis*, shaded.)

Family V. HEMISCYLLIIDÆ.

This group is closely allied to the *Scyliorhinidæ*, differing mainly in being ovoviviparous, the young being brought forth alive as in most sharks. The nasal and buccal cavities are confluent, the anal is behind the second dorsal, the large spiracles are more or less behind the eye, and the body is usually marked with dark cross-bands.

a. HEMISCYLLINÆ. Sides of head with no dermal flaps or cirri; spiracles very distinct below the eye; anal far behind second dorsal .... *Chiloscyllium*, 6.

aa. ORECTOLOBINÆ. Sides of the head with dermal flaps or cirri; spiracles wide, oblique slits behind and below the eye .... *Orectolobus*, 7.

6. CHILOSCYLLIUM Müller and Henle.

Chiloscyllium MÜLLER and HENLE, Plagiostomen, 1837, p. 17 (*plagiosum*).
Synchismus GILL, Am. Lyc. Nat. Hist. N. Y., 1861, p. 408 (*tuberculatus*).

Spiracle very distinct, below the eye. Nasal and buccal cavities confluent; nasal valve folded, with a cirrus. Lower lip well developed, continuous across the symphysis. Teeth small, triangular, with or without lateral cusps. Last two gill-openings close together. Dorsal

fins two, the first behind the front of ventrals. Anal far behind second dorsal, close to caudal. East Indies.

(χεῖλος, lip; *Scyllium*, a related genus of sharks.)

6. CHILOSCYLLIUM INDICUM (Gmelin).

Squalus sp. GRONOW, Mus. Ich., I, p. 61, No. 133; India (from a specimen in which the anal fin was cut away).

Squalus indicus GMELIN, Syst. Nat., I, 1788, p. 1503 (after Gronow).

Chiloscyllium indicum GÜNTHER, Cat. Fish, VIII, 1870, p. 411; China, Japan, India, Cape Seas, Java, Ceylon, etc. (and of most recent authors).—JORDAN and EVERMANN, Proc. U. S. Nat. Mus., 1902; Formosa.

Squalus gronovianus LACÉPÈDE, Hist. Nat. Poiss., I, 1798, p. 280, pl. XI, fig. 1 (after Gronow).

Squale dentelé LACÉPÈDE, Hist. Nat. Poiss., I, 1798, p. 281, pl. XI, fig. 1.

Squalus tuberculatus BLOCH and SCHNEIDER, Syst. Ichth., 1801, p. 137.

Synchisinus tuberculatus GILL, Am. Lyc. Nat. Hist. N. Y., 1861, p. 408.

Scyllium plagiosum BENNETT, Life of Raffles, 1830, p. 694.

Chiloscyllium plagiosum MÜLLER and HENLE, Plagiost., 1837, p. 17.—DUMÉRIL, Elasmobr., 1870, p. 328 (and of various authors).

Scyllium ornatum GRAY, Ind. Zool., III, 1830–35, pl. C, fig. 1; India.

Chiloscyllium griseum MÜLLER and HENLE, Plagiost., 1837, p. 19.

Chiloscyllium margaritiferum BLEEKER, Ned. Tyds. Dierk, I, 1851, p. 243.

Scyllium hasselti BLEEKER, Verh. Bat. Gen., XXIV, 1852, Plagiost., p. 19.

Scyllium phymatodes BLEEKER, Verh. Bat. Gen. Plagiost., p. 21.

Squalus caudatus GRONOW, Syst., Ed. Gray, 1854, p. 8.

Head 8 in length; depth 13; snout $2\frac{1}{2}$ in head; interorbital space $2\frac{2}{3}$; width of head $1\frac{1}{2}$ in its length; eye 3 in interorbital space; base of pectoral $2\frac{1}{2}$ in head; base of anal $1\frac{3}{4}$.

Body very elongate, slender, tail long and tapering. Head long, depressed, broadly rounded above, flattened below; snout broadly depressed, produced, and rounded above so that lateral profile is bluntly pointed; eyes small, high, lateral, rather far apart, in middle of length of head; mouth very broad, transversely straight, nearer eye than tip of snout; mandible with a broad, undivided flap, posterior edge undulated; teeth pointed, with a basal cusp on each side, numerous, rather small; nostrils large, confluent with corners of mouth, and each with a pointed barbel; interorbital space elevated a little, very broad, flattened. Spiracles very large, below and behind eye. Gill-openings about equal, the posterior above root of pectoral, and last two very close together.

Scales rather large and coarse.

Origin of first dorsal a little nearer tip of snout than origin of lower caudal lobe, similar to second dorsal, and only a trifle larger, space between two fins about equal to head; anal short, far behind second dorsal and only separated from caudal by a deep notch; pectorals broad, a little shorter than head, and nearer the tip of snout than origin of ventrals; ventrals before first dorsal, their tips reaching nearly to

middle of its base; caudal not bent up, upper lobe low, straight, and lower lobe long, deeper than upper and with a notch near its tip. Back with a low median keel.

Color in alcohol pale brown above, whitish beneath, and with thirteen broad deep brown cross-bars above, between which on median line of back a deep brown spot; sides of body and broad cross-bars with a number of light spots, of more or less irregular size, and some of those on sides of abdomen greatly enlarged.

Head with a number of pores.

Length $26\frac{1}{4}$ inches.

This description from a male from Formosa, loaned us by Dr. Shinnosuke Matsubara.

Coasts of China and Formosa, recorded once from Nagasaki by Günther.

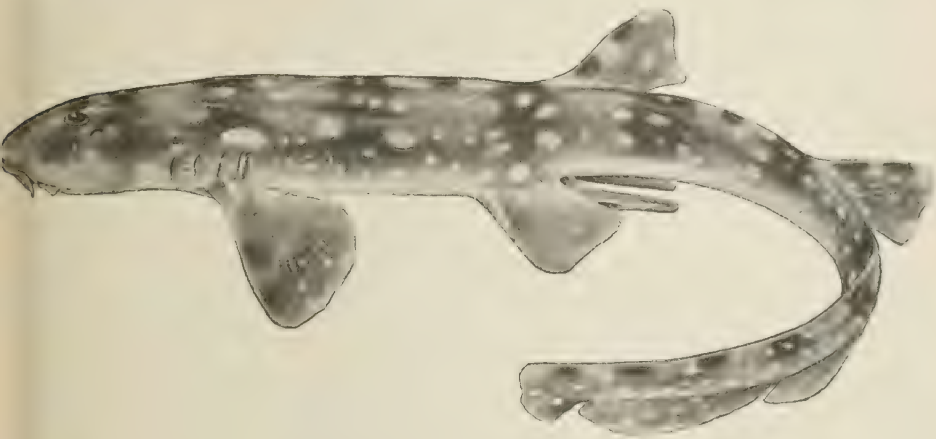


FIG. 2.—CHILOSCYLLIUM INDICUM.

The synonymy above given is from Günther; we have no means of valuing the nominal species included by Günther under the name of *Chiloscyllium indicum*.

7. ORECTOLOBUS Bonaparte.

Orectolobus BONAPARTE, Selach., 1836, p. 11 (*barbatus*).
Crossorhinus MÜLLER and HENLE, Plagiost., 1837, p. 21 (*barbatus*).

Spiracle a wide oblique slit behind and below the eye; nasal and buccal cavities confluent. Head broad, flat, the snout very obtuse; mouth wide, partly anterior, a free nasal cirrus; sides of head with numerous skinny flaps; chin with or without barbels. Lips well developed. Anterior teeth rather large, long, and slender, without lateral lobes; lateral teeth smaller, tricuspid in few series; last two gill-openings close together. First dorsal behind ventrals, the second before anal, which is very close to caudal. Tail short.

(ὀρεκτός, stretched out; λόβος, lobe).

7. ORECTOLOBUS BARBATUS (Gmelin).

Squalus barbatus GMELIN, Syst. Nat., 1788, p. 1493; New Holland (after Barbu of Broussonet, Act. Paris, 1780, p. 657).

Crossorhinus barbatus MÜLLER and HENLE, Plagiost., 1837, p. 21, pl. v.—SCHLEGEL, Fauna Japonica, Poiss., 1850, p. 301; Nagasaki.—DUMÉRIL, Elasmobr., I, 1870, p. 338; Australia, Japan, China.—GÜNTHER, Cat. Fish, VIII, 1870, p. 414; Japan, Tasmania, Australia.—MACLEAY, Australian Fishes, 1881, p. 301; Port Jackson.

Squalus maculatus BONNATERRE, Encycl. Meth., 1788, p. 8 (after Broussonet; Coll. Capt. Cook).

Squalus appendiculatus SHAW, Naturalists' Miscellany, 1809, p. 727.

Head $6\frac{1}{4}$ in length; depth 9; depth of body $1\frac{1}{2}$ in head; depth of head about $1\frac{3}{5}$ in its length; length of head $1\frac{1}{3}$ in its width; eye $9\frac{1}{2}$ in head; 2 in spiracle; $3\frac{1}{2}$ in snout; $4\frac{1}{2}$ in interorbital space; snout 3 in head, $1\frac{1}{3}$ in interorbital space; $1\frac{3}{4}$ in space between spiracles; width of mouth 2 in breadth of head; pectoral about $1\frac{1}{4}$; base of ventral $1\frac{3}{5}$ in length of pectoral; caudal peduncle 3 in space between spiracles.

Body elongate, very much depressed and broadened anteriorly; tail rather narrow, compressed, tapering. Head very broad, flattened, its breadth greater than length; snout broad, profile very blunt, truncate, with rounded edges, upper surface flat; eyes very small, superior, superorbital ridges slightly elevated and broadly flattened; jaws nearly equal, upper projecting beyond but little; teeth without cusps, sharp, elongate, pointed; lips very thick, fleshy, fringed inside; nostrils confluent with mouth, lateral, far apart, inferior; mouth with deep labial groove at corner, which is a little in front of eye; tongue broad, flat, compressed, little free in front; sides of head and snout each with 9 compressed dermal flaps or appendages of different sizes, first pair from nostrils are largest; interorbital space like rest of top of head, flat. Spiracles very large below and behind eyes. Gill-opening rather small, above pectorals.

Scales small, rough when stroked backwards.

First dorsal the larger, higher than second; space between its base and that of second two-thirds length of its own base, and its origin over posterior part of base of anal; origin of second dorsal nearer origin of ventral than tip of anal; anal smallest, beginning directly behind second dorsal; pectorals large, broad, margin truncate; ventrals nearer origin of anal than first gill-opening; caudal moderate, with a notch near tip, equal to space between origin of first dorsal and base of second posteriorly.

Color in spirits pale brown, whitish beneath; upper surface beautifully marbled and variegated with darker brown; crosswise about ten broad dark bars made up of similar mottlings; a whitish spot behind the corner of spiracle.

Length 33 inches (84 cm. 2 mm.).

Described from a female taken at Hakata.

Japan to Australia, rather common to the southward. Our specimens from Nagasaki, and one from Hakata, where it was found abundant. The identity of the Japanese species with the Australian *Orectolobus barbatus* is yet to be proved.

(*barbatus*, bearded.)

Family VI. CARCHARIIDÆ.

TYPICAL SHARKS.

Sharks with two dorsal fins, the first short and high, entirely before the ventrals, the second comparatively small, opposite the anal; no spines; gill-openings moderate, the last above the base of the pectorals; tail more or less bent upward from the base of the caudal fin; sides of tail not keeled; eyes with nictitating membranes; head not hammer-shaped, the snout longitudinally produced, as usual among sharks. Spiracles small or obsolete. Species oviparous.

A large family, found in all seas. The species are often closely related and difficult of determination.

a. MUSTELINÆ: Teeth flat and paved, without cusps or ridges; spiracles present; no pit at root of tail; labial folds well developed.

b. Teeth very blunt .... *Mustelus*, 8.

aa. CARCHARIINÆ: Teeth more or less compressed, with entire or serrate sharp edges.

c. Spiracles present.

d. Root of tail without pit.

e. Teeth rather small, each with a medium cusp and one or two small lateral cusps on each side.

f. Teeth larger, with sharp cusps; snout of moderate length; embryo not attached to uterus by a placenta .... *Triakis*, 9.

ee. Teeth larger, with a single cusp, oblique, notched and coarsely serrated on the outer margin .... *Galeus*, 10.

dd. Root of tail without conspicuous pit above; teeth all coarsely serrate, alike in both jaws, and all with a deep notch on outer margin; caudal fin with a double notch .... *Galeocerdo*, 11.

cc. Spiracles obsolete; lower teeth narrower than upper teeth.

g. Angle of mouth without groove or with merely a slight depression, which does not extend along either jaw.

h. First dorsal fin inserted posteriorly, nearer ventrals than pectorals; embryo not joined to the uterus by a placenta; slender sharks, with very strongly serrated teeth .... *Prionace*, 12.

hh. First dorsal inserted anteriorly, nearer pectorals than ventrals; embryo (so far as known) attached to the uterus by a placenta.

i. Teeth all serrate more or less (entire in the very young). *Carcharias*, 13.

gg. Angle of mouth provided with more or less distinct groove, which extends along one or both jaws; teeth entire, or very nearly so, more or less obliquely placed, their points turned away from the median line; embryo (so far as known) with placenta. *Scoliodon*, 14.

8. MUSTELUS Cuvier.

DOG SHARKS.

Mustelus Cuvier, Règne Animal, 1st ed., 1817, p. 128 (*mustelus*).
Pleuracromylon Gill, Proc. Ac. Nat. Sci. Phila., 1864, p. 148 (*lævis*).
Galeus Jordan and Evermann, Fish. N. Mid. Am., I, 1896, p. 29 (after Rafinesque 1810).

Body elongate, slender; snout comparatively long and flattened; mouth crescent shaped, with well-developed labial folds; teeth small, many rowed, flat and smooth, rhombic, arranged like pavement, alike in both jaws, and blunter than in any other sharks; eyes large, oblong; spiracles small, just behind the eyes; pectoral fins large; first dorsal large, not much behind pectorals; second dorsal somewhat smaller; anal opposite second dorsal and still smaller; ventrals well developed; basal lobe of caudal almost obsolete, the tail nearly straight; embryo attached to the uterus by a placenta, or else without placenta, those so attached belonging to the subgenus *Pleuracromylon*. Small sharks, among the smallest of the American species.

(*mustelus*, a weasel or marten; the same word used for shark, as is the synonymous word *galeus*.)

8. MUSTELUS MANAZO Bleeker.

MANAZO; HOSHIZAME (STAR-SPOTTED SHARK); HOSHINOKURI (STAR CHESTNUT).

Mustelus vulgaris Schlegel, Fauna Japonica, Poiss., 1850, p. 303, pl. cxxxiv; Nagasaki (not of Müller and Henle).—Nystrom, Köng, Svensk, Ak. Vet. 1887, p. 50; Nagasaki.
Mustelus manazo Bleeker, Verh. Bat. Gen., XXVI, 1854, Japan, p. 126; Nagasaki.—Günther, Cat. Fish, VIII, 1870, p. 387; Japan.—Duméril, Elasmobranches, I, 1870, p. 403 (after Bleeker).—Ishikawa, Prel. Cat., 1897, p. 62; Hokkaido, Boshu, Tokyo.—Jordan and Snyder, Proc. U. S. Nat. Mus. 1900, p. 336; Tokyo, Hakodate.

Head $6\frac{1}{2}$ in length; depth $11\frac{1}{2}$; width of head $1\frac{1}{2}$ in its length; depth of head 2; snout $2\frac{1}{2}$; width of mouth 3; interorbital space $2\frac{1}{3}$; eye $4\frac{4}{7}$; space between spiracles $1\frac{5}{6}$; pectoral about $1\frac{1}{5}$; height of dorsal $1\frac{2}{5}$; caudal peduncle $1\frac{1}{4}$ in eye.

Body long, slender, back elevated in front; tail long, tapering. Head broad, broader than greatest depth of body, depressed in front, elevated behind; snout greatly produced, depressed, flattened, rather broadly rounded; eyes elongate, lateral, in middle of length of head; mouth obtusely angular, breadth much greater than either of rami and tip of mandible not before eye; teeth small, pavement-like, in many rows; lips thin, at corners of mouth a fold on each side; nostrils very large; on lower surface of head, nearer eye and mouth than tip of snout; interorbital space broad, flattened. Spiracles small, very near posterior margin of eye. Gill-openings rather small, posteriorly above base of pectoral in front.

Body everywhere very finely roughened.

First dorsal larger than second, nearer origin of pectoral than that of ventral; origin of second dorsal nearer that of first dorsal than tip of caudal, and with greater part of its base in front of anal; anal smallest nearer caudal than ventral; pectorals a little larger than first dorsal, broad, very slightly emarginate; ventrals small, origin nearer that of anal than pectoral; caudal short, a little less than space between two dorsals. Caudal peduncle rather long, least depth greater than least width.

Color in spirits uniform grayish-brown, much darker above, pale below; upper surface of body anteriorly, also along the lateral line, marked with small, round, whitish spots.

Length 22 inches (56 cm.).

This description taken from our largest example, a male, secured at Tokyo.

Coasts of Japan, generally abundant in shallow bays, especially to the southward, our specimens from Hakodate, Aomori, Matsushima, Tokyo, Misaki, Kobe, Onomichi, Hiroshima, and Hakata. It is a small shark, reaching a length of about $2\frac{1}{2}$ feet, and is used for food. In young specimens the tips of the caudal and dorsals are blackish.

(*Manazo*, the Japanese name.)

9. TRIAKIS Müller and Henle.

Triakis MÜLLER and HENLE, Magazine of Natural History, II, 1838, p. 36, (*scyllium*).

Triacis, corrected spelling.

Body compressed, elongate; mouth large, crescent-shaped, with well-developed long labial folds; teeth moderate, numerous, similar in both jaws, each with a longer median cusp, and one or two smaller ones on each side; eyes small, with nictitating membrane; spiracles small, behind the eyes; no pit at the root of the caudal; no lower lobe to the caudal; first dorsal fin opposite the space between the pectorals and ventrals. Embryo without placenta. Coloration variegated, black and gray. Pacific and Indian oceans.

(*τρεῖς*, three; *ἀκίς*, point).

9. TRIAKIS SCYLLIUM Müller and Henle.

KOROZAME (KORO, INCENSE BURNER; ZAME, SHARK).

Triakis scyllium MÜLLER and HENLE, Plagiostomen, 1838, p. 63, pl. XXVI; Nagasaki.—DUMÉRIL, Elasmobr., 1870, p. 397 (after Müller and Henle).—JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1900, p. 336; Tokyo.

Triacis scyllium GÜNTHER, Cat. Fish, VIII, 1870, p. 384 (after Müller and Henle).—ISHIKAWA, Prel. Cat., 1897, p. 62; Tokyo, Sagami.

Head $6\frac{2}{5}$ in length; depth $8\frac{2}{3}$; width of head $1\frac{1}{2}$ in its length; depth of head 2; snout $2\frac{1}{2}$; interorbital space a trifle over 2; eye $6\frac{1}{4}$; width of mouth $2\frac{4}{5}$; snout to mouth $2\frac{2}{3}$; space between spiracles $1\frac{3}{4}$; base of dorsal $1\frac{1}{3}$; base of anal 2.

Body long, slender, back elevated, and tail compressed, tapering. Head depressed, flattened below, much broader than deep; snout in profile pointed, rounded, when seen from above very broadly rounded and flattened; eye small, lateral, with nictitating membrane; mouth very broad, crescent-shaped, not angular, so that it begins in front of eye and ends below middle; teeth small, numerous, sharp-pointed, tricuspid; labial fold at the corner of mouth on each side; nostrils large, on lower surface of head, nearer mouth than tip of snout; interorbital space broad, flattened. Spiracles small, directly behind eyes. Gill-openings lateral, posterior above base of pectoral.

Body entirely roughened, the prickles coarser above.

First dorsal large, a little nearer origin of second dorsal than tip of snout, also nearer origin of pectoral than that of ventral; second dorsal midway between posterior base of first dorsal and anterior base of lower caudal lobe; anal well behind second dorsal; pectoral shorter than head, its posterior margin slightly emarginate, reaching beyond middle of space between its own origin and that of ventral; ventrals nearer origin of anal than posterior base of pectorals; caudal small, $4\frac{1}{4}$ in total length. Caudal peduncle narrow, compressed above and beneath. Lateral line present along sides, superior.

Color dark gray brown, with a number of indistinct broad blackish cross-bars; in the upper surface of body a number of scattered, indistinctly defined, blackish spots; lower surface of body pale; sides and lower portions of pectorals and ventrals grayish brown.

Length $16\frac{1}{2}$ inches (47 cm.).

This description from an example from Tokyo.

Coasts of southern Japan; rather common in the Inland Sea. A small shark, reaching a length of about $2\frac{1}{2}$ feet. Our specimens from Tokyo, Tsuruga, Onomichi, and Hakata.

(*scyllium*, the cat shark; from σκύλω, to rend.)

10. GALEUS Rafinesque.

TOPES.

Galeus[a] Rafinesque, Caratteri Alcuni Nuovi Generi, 1810, p. 13, in part (*galeus*, etc., although that species is not explicitly mentioned, the first species mentioned being a species of *Pristiurus*, *P. melastomus*).

[a] From the definition, and from Rafinesque's custom of taking Linnæan specific names as generic, making such species always the types of his genera, we may infer that *Squalus galeus* was his type of *Galeus*. At least this arrangement may be accepted pending an agreement as to the generic nomenclature of sharks. In case the name *Galeus* is finally used for *Pristiurus* or for *Mustelus*, the present genus will become *Galeorhinus*. In a private notebook belonging to Rafinesque, now preserved in the Smithsonian Institution, he refers to *Galeus*, *Carcharias*, and several other genera named by Cuvier in 1817, as "described by me in 1810, but don't you tell it!" Pending a decision of the application of *Galeus* and *Carcharias* we retain them for the groups to which Rafinesque obviously intended the names to apply.

Galeorhinus BLAINVILLE, Bull. Sci. Philom., 1816, p. 121 (*galeus*).
Galeus CUVIER, Règne Animal, 1st ed., 1817, p. 127 (*galeus*).
Eugaleus GILL, Proc. Ac. Nat. Sci. Phila., 1864, p. 148 (*galeus*).

First dorsal opposite the space between the pectorals and ventrals; mouth crescent-shaped, with the teeth alike in both jaws, oblique, notched, and serrated; spiracles present, small; nictitating membrane present; no pit at the base of the caudal; caudal fin with a single notch. Tropical seas.

(γαλέος, a kind of shark, like a weasel.)

10. GALEUS JAPONICUS (Müller and Henle).

YERAKUFUKA.[a]

Galeus japonicus MÜLLER and HENLE, Plagiostomen, 1838, p. 58, pl. XXII; Nagasaki.—DUMÉRIL, Elasmobranches, I, 1870, p. 391 (after Müller and Henle).—GÜNTHER, Cat. Fish, VIII, 1870, p. 380 (after Müller and Henle).—NYSTROM, Kong, Svensk, Vet. Ak., 1887, p. 50; Nagasaki.

Head $6\frac{1}{5}$ in head; depth $9\frac{1}{5}$; width of head $1\frac{3}{5}$ in its length; interorbital space $2\frac{1}{2}$; snout $2\frac{2}{5}$; pectoral $1\frac{1}{4}$; width of mouth $2\frac{1}{5}$; eye $2\frac{1}{2}$ in interorbital space.

Body elongate, back elevated in front, sides compressed. Head greatly depressed, elongate, convex above, flattened beneath; snout pointed in profile; when viewed from above, roundly pointed, flattened; eyes elongate, lateral; nictitating membrane large, well developed; mouth crescent shaped, though rather bluntly obtuse at symphysis of mandible; corners of mouth each with a well-developed labial fold; teeth very oblique, without serrations on their edges, and with several short cusps behind; nostrils laterally inferior, moderately large, nearer mouth than tip of snout; interorbital space broad, slightly elevated and flattened in middle. Spiracle a small slit a short distance behind eye. Gill openings 5, in front of the base of pectoral above.

Surface of body finely roughened.

Dorsals similar, far apart, origin of first much nearer tip of snout than origin of second; origin of second dorsal much in advance of anal, nearer first dorsal than tip of snout, and midway between origin of ventral and origin of lower caudal lobe; anal small, its origin nearer caudal than ventrals; pectorals large, with emarginate edges, reaching beyond origin of dorsal; ventrals behind first dorsal, their origin nearer that of anal than origin of pectoral; caudal much larger than head, with a notch near tip so that terminal portion is one and two-thirds the lower lobe. Caudal peduncle long, much deeper than broad, flattened above and below, without any pit.

Color in alcohol light gray-brown, below lighter or whitish.

Length $26\frac{3}{4}$ inches.

[a] *Yeraku*, the antefeudal period; *fuka*, shark. Yeraku is the name of the period in Japanese history preceding the feudal period, or Tokugawa. It closed about 1600.

Described from a very large specimen from Nagasaki, where examples, 15 feet or more long, were seen.

A very large shark, reaching a length of 25 feet and a weight of nearly 2,000 pounds. The head of a huge specimen is in possession of M. Yahiro, proprietor of a natural-history shop in Nagasaki. It has the snout very short, nostrils midway in its length; teeth serrate, alike in both jaws, those in back deeply notched; width of jaws much exceeding snout; jaws with short labial fold; spiracles small; second dorsal a little smaller than first, slightly before anal; caudal considerably less than space between dorsals.

This species was taken at Onomichi, Hiroshima, and Nagasaki, and it appears to be generally common on the shores of Kiusiu.

11. GALEOCERDO Müller and Henle.

Galeocerdo Müller and Henle, Plagiostomen, 1838, p. 59 (*tigrinus*).
Boreogaleus Gill, Ann. Lyc. Nat. Hist. N. Y., VII, 1861, p. 411 (*arcticus*).

Mouth crescent shaped; teeth alike in both jaws, large, oblique, coarsely serrated on both margins, with a deep notch on outer margin; spiracles present; caudal fin with a double notch; a pit on the tail above and below at the base of the caudal fin; first dorsal opposite the space between pectorals and ventrals. Large sharks, found in most seas.

(γαλεός, a kind of shark, like γαλή, the weāsel; κερδώ, a fox or weasel.)

11. GALEOCERDO TIGRINUS Müller and Henle.

Galeocerdo tigrinus Müller and Henle, Plagiostomen, 1838, p. 59; Pondicherry.—Günther, Cat. Fish, VIII, 1870, p. 378; Japan, East Indies.—Duméril, Elasmobranches, I, 1870, p. 393; Pondicherry (Coll. Dussumier).

Head, $7\frac{1}{4}$ in length; depth, about 10; snout, $3\frac{1}{3}$ in head; interorbital space, $1\frac{1}{3}$; width of mouth at corners, about $1\frac{3}{5}$; eye, $5\frac{2}{3}$ in the interorbital space; space between nostrils, 2.

Body elongate, tapering to caudal. Head very much broader than deep, depressed; eyes small, lateral, nearer snout than gill opening; snout broad, short, rounded; mouth very broad, rounded; teeth numerous, rather large, compressed, with several basal cusps, and with edges more or less serrated; a labial fold at corners of mouth; nostrils large, inferior, about midway between tip of snout and eye; interorbital space very broad, flat. Spiracles very small behind eye. Gill openings large, posteriorly above base of pectoral.

Body very finely roughened.

First dorsal beginning about first fourth of interspace between origin of pectoral and that of ventral; second dorsal small, a little nearer origin of first dorsal than tip of caudal; anal small, beginning behind origin of second dorsal; pectorals rather long; ventrals very

much nearer anal than pectorals; caudal very long, lower lobe produced. Caudal peduncle rather short.

Color brown above, whitish or pale below, upper surface marbled or blotched with dark brown.

Length about 51 inches.

This description from a dried skin, a young male from Nagasaki, collected by M. Yahiro.

East Indies, rarely northward to southern Japan. Dr. Günther records a young specimen from Japan. It is probable that comparison will show that the American species, *Galeocerdo maculatus* (Ranzani), is distinct from *G. tigrinus*.

(*tigrinus*, tiger-like.)

12. PRIONACE Cantor.

Prionodon Müller and Henle, Plagiostomen, 1838, p. 36 (*glaucus*, etc., name preoccupied).

Prionace Cantor, Malayan Fishes, 1850, p. 399 (substitute for *Prionodon*).

Cynocephalus (Klein) Gill, Ann. Lyc. Nat. Hist. N. Y., 1861, p. 401 (*glaucus*).

Large sharks, with the body and head slender; no spiracles; the teeth in both jaws strongly serrated in the adult, those in the upper jaw broad, those below narrower, straight, and claviform; first dorsal large, inserted midway between axils of pectorals and ventrals; second dorsal much smaller, usually not larger than anal; embryo not attached to the uterus by a placenta. Species rather few; large, slender, swift, voracious sharks of the warm seas.

(πρίων, saw; ἀκίς, point.)

12. PRIONACE GLAUCA (Linnæus).

Squalus glaucus Linnæus, Syst. Nat., 10th ed., 1758, p. 235; seas of Europe.

Carcharias glaucus Günther, Cat. Fish., VIII, 1870, p. 364; England, St. Helena, Pondicherry, Port Arthur, Australia.—Duméril, Elasmobr., 1870, p. 353; New Zealand.

Carcharhinus glaucus Jordan and Gilbert, Synopsis, 1883, p. 22; San Francisco, Monterey.

Prionace glauca Jordan and Evermann, Fish North and Middle America, I, 1896, p. 33; San Francisco, Monterey.

Squalus cæruleus Blainville, Fauna Française, 1828, p. 91; Mediterranean.

Squalus hirundinaceus Valenciennes, in Müller and Henle, Plagiostomen, 1838, p. 37; Brazil.

Snout very long, nostrils rather nearer to mouth than to extremity of snout; no labial fold except a groove at angle of mouth; teeth of upper jaw oblique, scarcely constricted near base; lower teeth slender, triangular in young examples, lanceolate, with a broad base, in old ones. Pectoral fin long, falciform, extending to dorsal, which is nearer ventrals than root of pectorals. Color light bluish gray above, paler below.

A large shark of the warm seas, occasionally taken in Europe and on the coasts of Japan and California. A mounted specimen from off Misaki is in the Imperial Museum of Tokyo, and a photograph is in the Imperial University, taken from a large specimen secured at Misaki. We have no specimens. Whether this species is really identical with the European *glauca* is uncertain.

(γλαυκός, grayish blue.)

13. CARCHARIAS Rafinesque.

Carcharias RAFINESQUE, Caratteri Alcuni, Nuovi Generi, 1810, p. 10 (in intention; the only species named being *C. taurus*, an *Odontaspis*); *Squalus carcharias* RAFINESQUE, not of Linnæus, being the intended type as shown by the Indice d'Ittiologia Siciliana, 1810, p. 44, where the Pesce-Cane of Sicily is called *Carcharias lamia*. The definition of Rafinesque, copied from Lacépède, is intended to cover the sharks allied to *C. lamia*.

Carcharias CUVIER, Règne Animal, 1st ed., 1817, p. 125 (*carcharias*, expressly identified with *Canis carcharias* of Bélon [de Aquatilibus, I, p. 60], which is the species commonly called, after Rafinesque, *Carcharias lamia*).

Carcharinus BLAINVILLE, Journ. Phys., 1816, p. 264 (*commersoni*, a name based on Lacépède's figure of "*Squalus carcharias*;" it apparently represents *Carcharias lamia*).

Eulamia GILL, Ann. Lyc. Nat. Hist. N. Y., 1861, p. 401 (*lamia*).

Platypodon GILL, Ann. Lyc. Nat. Hist. N. Y., 1861, p. 401 (*menisorrah*).

Isogomphodon GILL, Ann. Lyc. Nat. Hist. N. Y., 1861, p. 401 (*oxyrhyncus*)

Lamiopsis GILL, Ann. Lyc. Nat. Hist. N. Y., 1861, p. 401 (*temmincki*).

Body rather robust. Head broad, depressed; mouth inferior; teeth in both jaws strongly serrated in adult, less so or entire in young; those in upper jaw broad or narrow, those below narrow, straight and nearly erect. No spiracles. First dorsal large, placed not far behind pectorals; pectorals falcate; second dorsal small. Embryos attached by placenta to the uterus, as in *Scoliodon*, *Triakis*, and *Galeus*. Species very numerous and difficult of separation. Voracious sharks of the warm seas.

If the name *Carcharias* be transferred to *Odontaspis*, the present genus must be called *Carcharhinus*.

(καρχαρίας, an old name of *C. lamia*, from χαρχαρός jagged; the name first applied to Squatina, from its rasp-like skin.)

13. CARCHARIAS JAPONICUS (Schlegel).

MEJIRO (WHITE EYE); WANIZAME (CROCODILE-SHARK).

Priomodon japonicus SCHLEGEL, Fauna Japonica, Poiss , 1850, p. 302; Nagasaki.

Head 5[illegible] in length; depth about 7; snout 2[illegible] in head; width of mouth 2[illegible]; interorbital space 1[illegible]; pectoral about 1[illegible]; snout from tip to tip of mandible 2½; eye 4 in interorbital space.

Body rather elongate, back high, elevated, tail compressed and tapering. Head very broad, depressed, flattened, neck and back rapidly becoming elevated behind; snout in profile elongate, more or

less roundly pointed, when viewed from above very broad, rounded, not forming distinct point, flattened like rest of top of cranium; eyes small, lateral, nearer tip of snout than first gill-opening; breadth of mouth much greater than length of either of rami of mandible, which form a rounded angle at symphysis; teeth finely serrate, upper rather broad, compressed, lower more elongate; nostrils large, on lower surface of snout, nearer tip of mandible than tip of snout; interorbital space very broad, flat, slightly convex in middle. Gill-openings rather small, last above base of pectoral.

Body finely roughened.

First dorsal about midway between tip of snout and origin of second dorsal, elevated, its height a little greater than interorbital space; second dorsal small, low, much nearer origin of first dorsal than tip of caudal; anal small, its origin nearer that of pectoral than tip of caudal, a little before second dorsal; pectoral large, nearer tip of snout than origin of ventral; ventrals rather low, much nearer anal than pectoral; caudal three and three-fifths in body, lower lobe low. Caudal peduncle rather thick, rounded, flattened above and below, and with deep pit at its base above.

Color in alcohol deep gray-brown above, lower surface of body whitish; terminal portions of fins more or less white.

Length $17\frac{1}{8}$ inches (43 cm. 5 mm.).

This description from a small specimen from Kawatana.

Coasts of Japan. A large shark, generally common. Specimens were seen at Hakodate, Tokyo, Wakanoura, Kawatana, and Nagasaki. A head in Yahiro's collection is from a specimen 25 feet long, and said to have weighed 2,000 pounds. It presents the following characters: Snout rather short, acute, bluntish at tip; nostrils midway between tip of snout and mouth; the eye much nearer angle of mouth; width of mouth almost twice length of snout; teeth not large, uppermost faintly serrate, subtriangular, without distinct notch on lower margin, and lower teeth erect, almost entire, long, narrow.

In young of 3 feet the snout is obtuse, and a little longer than mouth is broad; eye about midway between angle of mouth and snout; teeth weakly serrate, small, upper broad, not notched, nearly erect, and lower narrow; second dorsal small, smaller than anal; pectoral to near end of dorsal, long, narrow; first dorsal not dusky; second dorsal, pectoral, and lower lobe of caudal tipped with black.

This species has been identified with *Carcharias gangeticus*, *Carcharias melanopterus*, and *Carcharias bleekeri*, but it seems to be distinct from all other East Indian and Polynesian species, and there seems to be no evidence that any of these occur in Japan. *Carcharias melanopterus* of Polynesia has the fin lobes much blacker than in *C. japonicus*.

One small specimen from Nagasaki differs only in having a slightly more pointed snout.

14. SCOLIODON Müller and Henle.

Scoliodon MÜLLER and HENLE, Wiegmann's Archiv. f. Naturg., 1837, I, p. 397 (*laticaudus.*)

Teeth entire, or very nearly so, oblique and flat, the points directed toward the sides of the mouth, so that the inner margins are more or less nearly horizontal, the teeth in front more nearly erect; teeth not swollen at the base, each of them with a deep notch on the outer margin below the sharp point; lips with conspicuous grooves. Otherwise as in *Carcharias*, from which the genus is scarcely distinct. Size small.

(σκολιός, oblique; ὀδούς, tooth.)

a. Length of the anal nearly equal to its distance from ventrals; outer angle of pectorals almost a right angle; pectorals black; upper jaw without labial fold. *laticaudus*, 14.

aa. Length of anal much less than its distance from ventrals; outer angle of pectorals acute.

b. Upper jaw without labial groove; length of snout about equal to distance of eye from gill opening .... *acutus*, 15.

bb. Upper jaw with a short labial groove; cleft of mouth much broader than long .... *walbeehmi*, 16.

14. SCOLIODON LATICAUDUS (Müller and Henle).

Carcharias (*Scoliodon*) *laticaudus* MÜLLER and HENLE, Plagiostomen, 1838, p. 28, pl. VIII; East Indies.—DUMÉRIL, Elasmobranches, II, 1870, p. 343 (same types).

Carcharias laticaudus GÜNTHER, Cat. Fish., VIII, 1870, p. 358; Bengal, East Indies, China, Amoy, Japan.

Carcharias (*Scoliodon*) *macrorhynchus* BLEEKER, Verh. Bat. Gen., XXIV, 1851, Plagiost., p. 31, pl. I, fig. 1; Batavia.—DUMÉRIL, Elasmobranches, II, 1870, p. 343 (after Bleeker).

Snout from front margin of mouth equal to, or a little more than, distance of eye from gill-opening; a very short labial groove at angle of mouth, not extending on upper jaw, and for a very short distance only on lower. Pectoral fin with posterior margin nearly straight, upper angle nearly a right one, not extending to first dorsal; base of anal equal to, or but little less than, its distance from ventral, and its pointed lobe terminates at a distance from root of caudal; terminal lobe of caudal obliquely truncated. Pectoral fins black. Length, 18 inches. (Günther.)

East Indies; noted by Dr. Günther from Jamrach's Collection in Japan, a record which needs verification.

(*latus*, broad; *cauda*, tail.)

15. SCOLIODON ACUTUS (Rüppell).

Carcharias acutus RÜPPELL, Neue Wirbelthiere, Fische, 1837, p. 65, pl. XVIII, fig. 4; Red Sea.—GÜNTHER Cat. Fish., VIII, 1870, p. 358; Cape Seas, Pinang, Vizagapatam, Japan.

Carcharias (*Scoliodon*) *acutus* Müller and Henle, Plagiostomen, 1838, p. 29. Cantor, Malayan Fishes, 1850, p. 399.—Duméril, Elasmobranches, II, 1870, p. 345; East Indies, China.

Snout from front margin of mouth equal to, or a little less than, distance of eye from gill-opening; very short labial groove at angle of mouth, not extending on upper jaw, and for a very short distance only on lower. Pectoral with posterior margin slightly concave, upper angle pointed, extending to, or somewhat beyond, origin of dorsal; length of base of anal one-half, or less, its distance from ventral; its pointed terminal lobe terminates not far from root of caudal; terminal caudal lobe tapering. Posterior margin of pectoral whitish, upper margin of caudal blackish. Length 17 inches. (Günther.)

East Indies: Noted by Dr. Günther as collected by Mr. Jamrach in Japan. This record needs verification.

16. SCOLIODON WALBEEHMI (Bleeker).

Carcharias (*Scoliodon*) *walbeehmi* Bleeker, Nat. tyds. Ned. Ind., X, 1856, p. 353; Bintang.—Duméril, Elasmobranches, II, 1870, p. 344 (after Bleeker).
Carcharias walbeehmi Günther, Cat. Fish., VIII, 1870, p. 359; Bintang, Japan.—Nystrom, Kong, Svensk. Vet. Ak., 1887, p. 50; Nagasaki.
Scoliodon walbeehmi Jordan and Evermann, Proc. U. S. Nat. Mus., XXV, 1902, p. 318; Formosa.

Snout from front margin of mouth, more than distance of eye from gill-opening; a short labial groove at angle of mouth extending for a short distance on upper jaw as well as lower; distance between outer angles of nostrils equal to that of nostril from extremity of snout. Pectoral fin with posterior margin slightly concave and upper angle pointed, extending somewhat beyond origin of dorsal fin; the length of base of anal fin is about two-fifths of its distance from ventral, and its pointed terminal lobe terminates at some distance from root of caudal; terminal caudal lobe tapering. Coloration uniform. (Günther.)

Coasts of southern Japan, not common. This or some related species was seen at Nagasaki, and at Kawatana on the bay of Omura, but no specimens were secured. We have examined a specimen from Formosa.

(A personal name.)

Family VII. SPHYRNIDÆ.

HAMMER-HEADED SHARKS.

General characteristics of the *Carchariidæ*, but the head singularly formed, kidney-shaped or "hammer"-shaped, from the extension of its sides, the nostrils being anterior and the eyes on the sides of the "hammer;" mouth crescent-shaped, under the "hammer;" teeth of both jaws similar, oblique, each with a notch on the outside near the

base; no spiracles; last gill-opening over the pectoral; first dorsal and pectorals large, the dorsals nearer pectorals than ventrals; second dorsal and anal small; a pit at the root of the caudal; caudal fin with a single notch toward its tip, its lower lobe developed. One genus with 5 species, inhabiting most warm seas. Large sharks, known at once by the singular form of the head, which is not quite the same in any two species.

15. SPHYRNA Rafinesque.

Sphyrna RAFINESQUE, Indice d'Ittiol, Siciliana, 1810, p. 60 (*zygæna*).
Cestrorhinus BLAINVILLE, Journ. Phys., 1816, p. 264 (*zygæna*).
Zygæna CUVIER, Règne Animal, 1st ed., 1817, p. 127 (*zygæna;* name preoccupied in Insects).
Platysqualus SWAINSON, Classn. Anim., II, 1839, p. 318 ("*tiburo*"=*tudes*).
Cestracion KLEIN (pre-Linnæan) in Gill, Ann. Lyc. Nat. Hist. N. Y., VIII, 1861, p. 412 (*zygæna*).
Eusphyra GILL, Ann. Lyc. Nat. Hist. N. Y., VIII, 1861, p. 412 (*blochii*).
Reniceps GILL, Ann. Lyc. Nat. Hist. N. Y., VIII, 1861, p. 412 (*tiburo*).

Characters of the genus included above. In the form of the head, there is a perfect gradation among the species, from the narrow hammer of *S. blochii*, with the lobes three times as long as broad and deeply grooved along the anterior edge, to the kidney-shaped head of *S. tiburo*, in which the anterior grooves are obsolete.

(σθύρα, hammer.)

SPHYRNA:

a. Nostril with a well-developed groove, which extends along the front of the hammer-shaped head, the anterior and posterior outlines of which are nearly parallel .... *zygæna*, 17.

17. SPHYRNA ZYGÆNA (Linnæus).

SHINOKUZAME (HAMMER SHARK); KASEBUKA (CROSS-STAFF SHARK).

Squalus zygæna LINNÆUS, Syst. Nat., 10th ed., 1758, p. 234; Europe, America.
Cestracion zygæna DUMÉRIL, Elasmobranches, II, 1870, p. 382.
Sphyrna zygæna JORDAN and GILBERT, Synopsis, 1883, p. 25.—JORDAN and EVERMANN, Fish. North and Mid. Am., I, 1896, p. 45; Cape Cod, Point Conception.
Squaleus malleus RISSO, Ichth. Nice, 1810, p. 34; Nice.
Zygæna malleus SCHLEGEL, Fauna Japonica, 1847, p. 306, pl. CXXXVIII; Nagasaki.—STORER, Fish. Mass., 1867, p. 238.—GÜNTHER, Cat., VIII, 1870, p. 381.—NYSTROM, Kong, Svensk, Vet. Ak., 1887, p. 49; Nagasaki.
?*Zygæna lewini* LORD, in Griffith, Animal Kingdom, X, 1834, p. 640; Leeuwen, Australia.
Zygæna subarcuata STORER, Proc. Bost. Soc. Nat. Hist., 1848, p. 70; Cape Cod.

Head truly hammer-shaped; width of head about twice its length; length of hinder margin of hammer nearly equal to width near eye; nostril close to eye; prolonged into a groove which runs along nearly the whole front margin of head; first dorsal large; second quite small, smaller than anal; pectoral rather large. Color gray.

A large voracious shark, reaching a length of 15 feet or more, found

in all warm seas; occasionally northward to California, Massachusetts, and France, rather common in Japan, as far northward as Tokyo. Our specimens from Nagasaki, Misaki, and Wakanoura. The species needs comparison with the Hammer-head shark of Atlantic.

(ζύγαινα, *Zygæna*, the ancient name, from ζυγόν, yoke.)

Family VIII. ALOPIIDÆ.

THRESHER SHARKS.

Body moderately elongate, the snout rather short; mouth crescent-shaped; teeth equal in both jaws, moderate sized, flat, triangular, not serrated; the third tooth of the upper jaw on each side much smaller than the others; gill-openings moderate, the last one above the root of the pectorals; no nictitating membrane; spiracles just behind eye, minute or absent; first dorsal large, midway between pectorals and ventrals; second dorsal and anal very small; caudal fin exceedingly long, about as long as the rest of the body, a pit at its root, a notch on the upper lobe near its tip; lower lobe moderately developed; no caudal keel; ventrals rather large; pectorals very large, falcate. A single species, reaching a large size, inhabiting most seas, known at once by the great length of the tail.

16. ALOPIAS Rafinesque.

Alopias Rafinesque, Caratteri di Alcuni Generi, 1810, p. 12 (*macrourus*=*vulpes*).
Alopecias Müller and Henle, Plagiostomen, 1838, p. 74 (amended orthography).

The characters of the genus are included above.

(ἀλωπός, a fox; Latin, *vulpes*. A. *vulpes* was known to the ancients as ἀλωπεκίας, fox-like.)

18. ALOPIAS VULPES (Gmelin).

ONAGAZAME (LONG-TAILED SHARK); NADEBUKA (SMOOTH SHARK); NEZUMEZAME (RAT-TAILED SHARK).

Squalus vulpes Gmelin, Syst. Nat., I, 1788, p. 1496; Mediterranean (after Pennant).
Carcharias vulpes De Kay, New York Fauna, IV, Fishes, 1842, p. 348, pl. LXI, fig. 199.
Alopias vulpes Duméril, Elasmobr. I, 1865, p. 421.—Day, Fishes of India, Supplement, 1888, p. 810.—Jordan and Gilbert, Synopsis, 1883, p. 27.—Jordan and Evermann, Fish. North and Middle America, I, 1896, p. 45.
Alopecias vulpes Günther, Cat. Fish., VIII, 1870, p. 393.
Squalus vulpinus Bonnaterre, Tableau Encycl. Ichthy., 1788, p. 9; Mediterranean (after Pennant).
Alopias macrourus Rafinesque, Caratteri di Alcuni Generi, 1810, p. 12; Sicily,
Squalus alopecias Gronow, Cat. Fishes, 1854, p. 7.

Body fusiform, cylindrical, thickest before dorsal fin; back regularly arched from above pectorals to end of snout, and gradually decreasing in size posteriorly to caudal. Head short, bluntly conical;

snout blunt; eye rather large; mouth horse-shoe shaped, teeth about $\frac{22-22}{19-19}$, third or fourth tooth on either side of center of upper jaw smaller than others. Spiracles very small or wanting. Last gill-openings above or slightly in front of pectorals.

Body more or less roughened.

First dorsal high, triangular, somewhat higher than its base is long, slightly slender toward its summit, superior angle rounded; second dorsal similar in shape, but much smaller; anal small, placed behind second dorsal, which it resembles; pectorals long, wide, emarginate, with small process behind; ventrals wider than high, nearest first dorsal; caudal nearly as long or longer than body, composed of three distinct lobes, one small, triangular, at under side of tip, a second long and low, extending along upper side of tail, and a third short and broad, at lower base of tail.

Color, slate-blue above, beneath soiled white, marked with obsolete bluish spots; pupils a longitudinal slit, edged with golden.

Length, 12 feet.

A large shark, abounding in all warm seas, common on the east coast of Japan. It was seen at Misaki, Nagasaki, Tokyo, and Yokahama. No one has yet compared specimens of the Japanese fish with those from California or the Mediterranean, and the species may prove different.

(*vulpes*, fox.)

Family IX. MITSUKURINIDÆ.

Skeleton flexible; snout produced in a flat, flexible blade varying in length; spiracles large; teeth acicular, only the lateral ones with small basal cusps; last gill-opening above base of pectorals; fins all low, the ventral with very long base; the claspers very small; lower lobe of caudal long; no pit at root of caudal; first dorsal well advanced; second shorter and higher than anal.

Two genera are known: *Mitsukurina*, and the extinct genus *Scapanorhynchus* of the Eocene. Dr. Arthur Smith Woodward regards *Mitsukurina* as identical with *Scapanorhynchus*. In the latter genus, however, the rostral blade is much longer than in *Mitsukurina*, and minor differences are apparent.

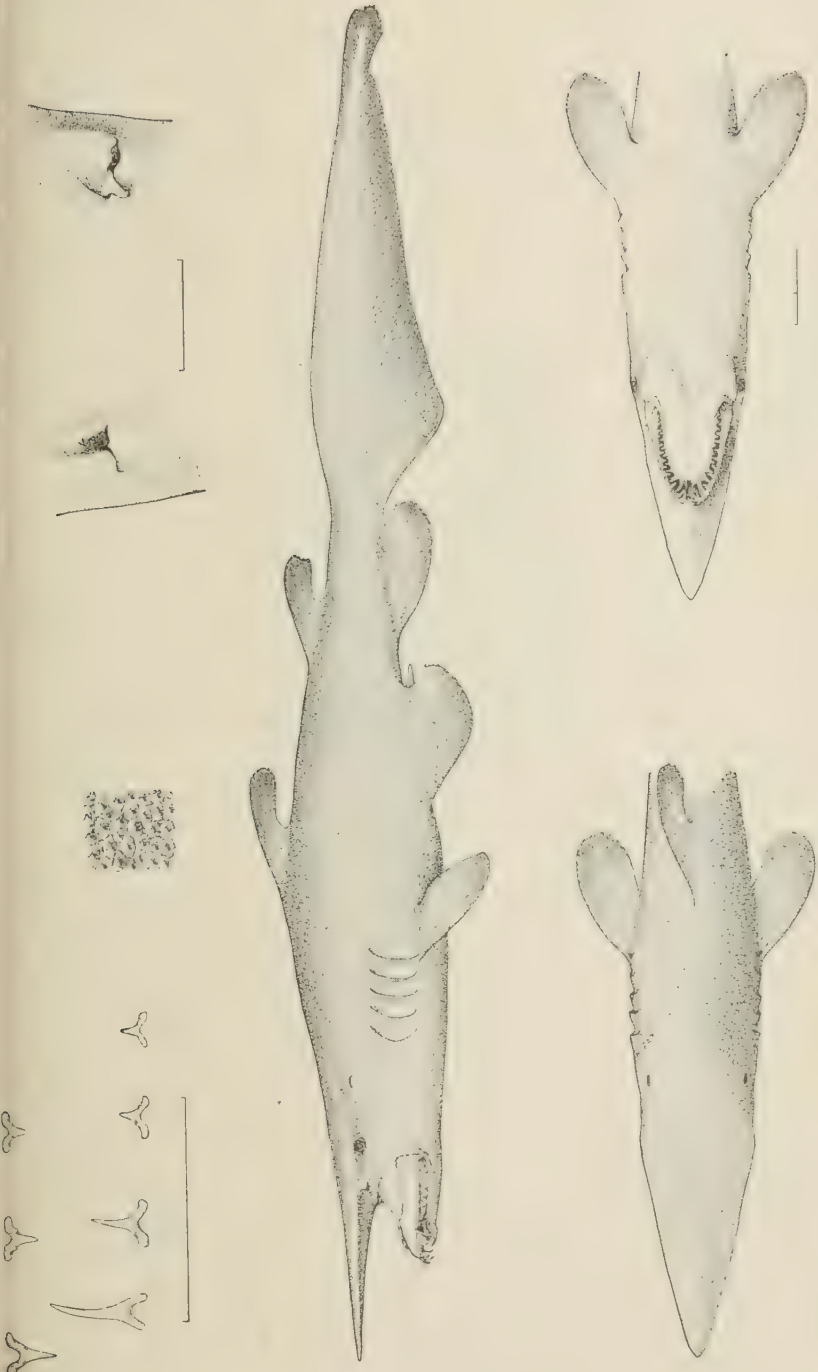
The family is closely allied to the *Odontaspididæ*, differing in the produced snout.

17. MITSUKURINA Jordan.

Mitsukurina JORDAN, Proc. Cal. Acad. Sci., 1898, p. 200 (*owstoni*).

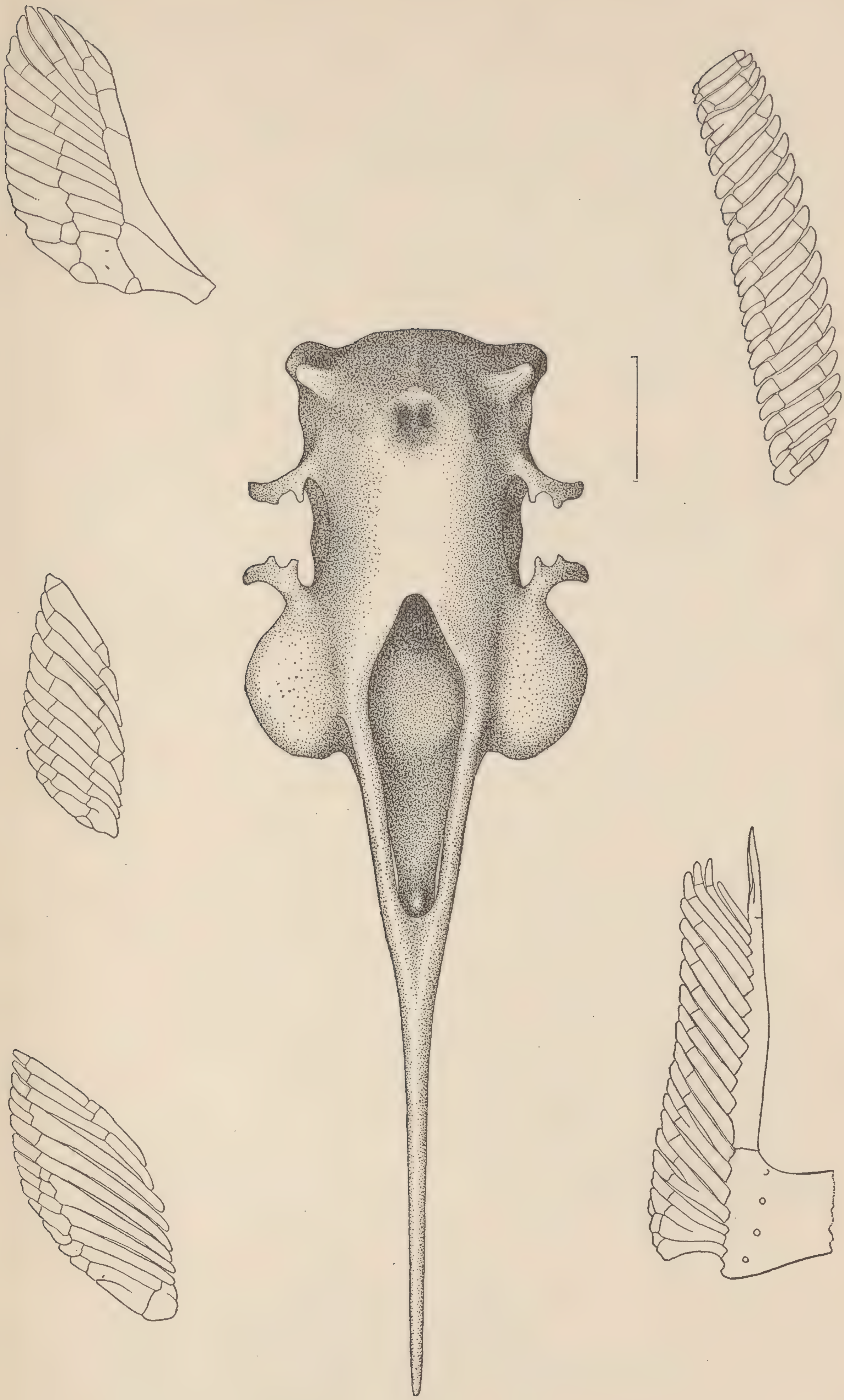
Characters of the genus included above.

(Named for Kakichi Mitsukuri, professor of zoology in the Imperial University of Tokyo.)



MITSUKURINA OWSTONI JORDAN.

FOR EXPLANATION OF PLATE SEE PAGE 621.



MITSUKURINA OWSTONI JORDAN.

FOR EXPLANATION OF PLATE SEE PAGE 621.

19. MITSUKURINA OWSTONI Jordan.

Mitsukurina owstoni JORDAN, Proc. Cal. Ac. Sci., 1898, p. 200; Misaki.

Length of specimen, apparently young male, 42 inches. Head (to first gill-opening) $4\frac{2}{3}$ in length; depth about 10; snout from eye $1\frac{2}{5}$ in head; from front of mouth $2\frac{4}{7}$; length of blade of snout from its insertion below $1\frac{4}{5}$; length of gill area $2\frac{2}{3}$; depth of last gill 6; eye 12 in snout from eye; interorbital area $2\frac{2}{3}$; spiracle a little smaller than eye; length of one mandible $2\frac{2}{5}$ in head; length of maxillary $2\frac{2}{5}$; pectoral base $1\frac{3}{4}$ in length of pectoral fin, which is $2\frac{2}{3}$ in head; first dorsal base $1\frac{3}{4}$ in its height, which is $2\frac{3}{4}$ in head; second dorsal base $1\frac{3}{4}$ in its height, which is 3 in head; ventral base 2 times its height, length of base 3 in head; claspers very short (perhaps immature), nearly 12 in head; anal base $2\frac{1}{3}$ times its height and $2\frac{4}{5}$ in head; caudal, measured from above, $2\frac{4}{5}$ in length of body; greatest height of lower lobe nearly 3 in head.

Body elongate, compressed behind, flesh and skeleton extremely limp, folding like a wet rag. Head moderate; snout produced in a long, flat, flexible, leaf-like blade, somewhat like that of *Polyodon spathula* but narrower, more limp and more pointed; median line of snout with a thick, rounded median keel; lower side of the blade free for a considerable distance backward from upper jaw, almost to eyes; eye small, without nictitating membrane; mouth inferior, with elongate cleft; dentary bones broad, loosely connected, movable, capable of being spread wide apart, but normally lying close together and nearly parallel; a notch at symphysis, tip of lower jaw strongly curving upward and inward; similar notch at tip of upper jaw between rather loosely joined maxillary; middle of each jaw without teeth in front; teeth few-rowed, about $\frac{1}{1}\frac{3}{2}$ on each side, all needle-shaped, very slender, pointed, more or less curved backward and inward; each tooth with a two-rooted base, large teeth in front simple, smaller ones on sides of jaws each with two small basal cusps; second and third tooth of lower jaw longest; the second about as long as eye; first and second tooth of upper jaw similar to these but somewhat shorter; lateral teeth of both jaws progressively smaller, but all slender and sharp; nostrils large, about as large as eye, their distance from eye twice the eye; each nostril with a small notch on lower edge and a free flap within. Spiracle large. Gill-openings about equal in height, the last above base of pectoral.

Skin everywhere rough, the scutes very small, granulated No lateral line or conspicuous mucous pores.

Fins all thin, flexible, papery, the broad bones somewhat exserted from soft flesh; first dorsal short, moderately high, not emarginate, the insertion above axil of pectoral, second dorsal lower, remote from first, interspace $1\frac{1}{2}$ in head, the insertion nearly midway between

ventrals and anal; anal much longer than second dorsal, rather lower; pectorals short, narrow, rounded flexible rays longest; ventrals with very long base; no caudal keel; no pit at root of caudal; lower lobe of caudal long and rather high, with a sharp notch near its tip.

Color light reddish gray, brownish above; fins darker brown; nuchal region a little darker; belly paler. (Jordan.)

The type specimen, now in the Imperial University of Tokyo, was captured in deep water off Misaki and presented by Capt. Alan Owston, of Tokohama, for whom it is named. Captain Owston has had engravings of this species made, and scattered them far and wide among the Japanese fishermen, but until 1902 he found no second specimen and no one who knew the fish. In a recent letter (November, 1902) he announces the acquisition of another specimen.

Family X. LAMNIDÆ.

MACKEREL SHARKS.

Sharks of large size, with the body stout, the mouth wide, with large teeth, and the tail slender, the caudal fin lunate, the two lobes not very unequal, the upper lobe strongly bent upward; caudal peduncle with a strong keel on each side; gill-openings wide, all in front of the pectorals, entirely lateral, not extending under the throat; first dorsal large; pectorals large; ventrals moderate; second dorsal and anal very small; a pit at the root of the caudal; spiracles minute or absent. Numerous fossil species are known. In this family the dentition, as well as the muscular system, reaches its highest degree of specialization known among sharks.

a. LAMNINÆ: Teeth slender and sharp, with entire edges.
  b. Teeth without basal cusps, long, flexuous, acute; first dorsal inserted nearly midway between pectorals and ventrals .... *Isuropsis*, 18.
  bb. Teeth each with one or two basal cusps; first dorsal not far behind pectorals. *Lamna*, 19.
aa. CARCHARODONTINÆ: Teeth with serrated edges, compressed, triangular in form, without basal cusp .... *Carcharodon*, 20.

18. ISUROPSIS Gill.

Isuropsis GILL, Ann. Lyc. Nat. Hist. N. Y , VIII, 1861, p. 153 (*glaucus*).

Snout rather long and pointed; the body formed much like that of a tunny or mackerel; first dorsal large, inserted, entirely behind pectorals, nearly midway between pectorals and ventrals; pectorals large; second dorsal and anal very small; caudal peduncle slender; teeth long, lanceolate, with sharp, entire cutting edges and no basal cusps.

(*ἴσος*, equal; *οὐρά*, tail; the two lobes of the tail being nearly equal; *ὄψις*, appearance. From *Isurus* it is separated by the backward insertion of the dorsal.)

20. ISUROPSIS GLAUCA (Müller and Henle).

AOZAME (BLUE SHARK); MOROZAME.

Oxyrhina glauca Müller and Henle, Plagiostomen, 1838, p. 69, pl. xxix; Nagasaki (erroneously stated to be from Java).—Schlegel, Fauna Japonica, Poiss., 1850, p. 303; Nagasaki.—Duméril, Elasmobranches, 1870, p. 409 (after Müller and Henle).

Lamna glauca Günther, Cat. Fish., VIII, 1870, p. 391; Cape Seas, St. Helena.

Snout long, pointed; teeth in four rows, very long, flexuous, without denticles at base. Spiracles very small. First dorsal inserted well backward, midway between pectoral and ventral, scarcely longer than high, its upper angle rounded. Color dark blue, white below.

Coasts of Japan and southward, rather common about Nagasaki. Many jaws and a stuffed fœtus are in possession of Mr. Yahiro. A specimen 7 feet long was taken by Jordan and Snyder at Matsushima, the head having been preserved.

(*glaucus*, hoary blue.)

19. LAMNA Cuvier.

Lamna Cuvier, Règne Animal, 1st ed., 1817, p. 126 (*cornubicus*).

Lamia Risso, Eur. Merid., III, 1826, p. 123 (*cornubicus*, name preoccupied).

Selanonius Fleming, British Animals, 1828, p. 169 (*walkeri=cornubicus*).

Body short and stout, the back considerably elevated; snout prominent, pointed; teeth triangular, pointed, entire, each one with a small cusp on each side at base; one or both of these sometimes obsolete on some of the teeth in the young; gill-openings wide; dorsal and pectoral fins somewhat falcate; second dorsal and anal fins very small, nearly opposite each other; first dorsal close behind the root of the pectorals. This genus is very close to *Isurus*, with which fossil forms seem to connect it. Perhaps the two should be united under the older name, *Isurus*.

(*λάμνα*, a kind of shark, from *λαμία*, a horrible anthropophagous monster, a bugbear used by the Greeks to frighten refractory children.)

21. LAMNA CORNUBICA (Gmelin).

SALMON SHARK; MACKEREL SHARK; PORBEAGLE.

Squalus cornubicus Gmelin, Syst. Nat., I, 1788, p. 1497; shores of Cornwall (after Beaumaris of Pennant).

Lamna cornubica Günther, Cat. Fish., VIII, 1870, p. 389.—Jordan and Gilbert, Synopsis, 1883, p. 30.—Jordan and Evermann, Fishes North and Middle Am., I, 1896, p. 19 (and of most authors).

Snout conical, pointed, rather longer than cleft of mouth; teeth $\frac{12-14}{10-14}$ on each side; third tooth on each side in the upper jaw small; first dorsal beginning over axil of pectorals. Color bluish gray. A large and fierce pelagic shark reaching a length of 10 feet. (Jordan and Evermann.)

Common in Europe and rather frequent on the coast of southern Alaska, where it is very destructive to the salmon, thence southward to California. It has been ascribed to Japan by Dr. Günther, and may occur in Japanese waters, but no authentic record exists, and no specimens are in Japanese museums. It is unknown to naturalists at Nagasaki, but it may be looked for at the mouths of salmon rivers, as the Ishigari, in Hokkaido.

(*cornubicus*, from Cornwall, from which region the species was early described.)

20. CARCHARODON Smith.

MAN-EATER SHARKS.

Carcharodon ANDREW SMITH, Proc. Geol. Soc. London, V, 1837, p. 86 (*capensis*=*carcharias*).

General characters of *Isurus* and *Lamna*, but with a different dentition, the teeth being large, flat, erect, regularly triangular, their edges serrated; first dorsal moderate, nearly midway between pectorals and ventrals; second dorsal and anal very small; pectorals large, ventrals moderate; caudal peduncle rather stout; spiracles minute or absent. Sharks of very large size; the strongest and most voracious of all fishes; pelagic, found in most warm seas.

(κάρχαρος, jagged; ὀδούς, tooth.)

22. CARCHARODON CARCHARIAS (Linnæus).

MAN-EATER SHARK; GREAT WHITE SHARK.

Lamia RONDELET, Hist. Poiss., 1558, p. 305; Nice, Marseilles (good figure).

Squalus carcharias LINNÆUS, Syst. Nat., 10th ed., 1758, p. 235; Europe (after Artedi; not of most later authors).

Carcharodon carcharias JORDAN and GILBERT, Synopsis, 1883, p. 875.—JORDAN and EVERMANN, Fish. North and Middle Am., I, 1896, p. 50.

Carcharias verus AGASSIZ, Poiss. Foss., III, 1836, p. 91.

Carcharodon rondeleti MÜLLER and HENLE, Plagiostomen, 1838, p. 70; Mediterranean Sea and Atlantic Ocean (after Rondelet).

Carcharodon rondeleti GÜNTHER, Cat. Fish., VIII, 1870, p. 392.

Carcharias atwoodi STORER, Proc. Bost. Soc. Nat. Hist., II, 1848, p. 71; Provincetown, Massachusetts.

Carcharodon capensis SMITH, III, Zool. S. Africa, 1842, pl. IV; Cape of Good Hope.

Carcharodon smithi BONAPARTE, Selach. Tab. Anal., 1839, p. 9 (after Smith).

Body stout; depth about $5\frac{1}{2}$ in total length; mouth very large; both jaws with five rows of large, triangular, serrated teeth, those in lower jaw narrower, about $\frac{13}{2}\frac{13}{2}$ in each row; first dorsal somewhat behind pectorals; caudal fin large and strong. Color leaden gray; tips and edges of pectorals black. One of largest of sharks, reaching a length of 30 feet. It is found in all temperate and tropical seas, and is occasionally taken both in the Atlantic and Pacific. One caught near Soquel, California, was about 30 feet long and had a young sea lion,

weighing about 100 pounds, in its stomach. (Jordan and Evermann.)

A large pair of jaws is preserved in the museum of the Imperial University, taken somewhere off the east coast of Hondo, near Misaki. This constitutes the only record of the species from Japan.

(καρχαρίας, an old name of *Carcharias lamia* and of other man-eating sharks.)

Family XI. CETORHINIDÆ.

BASKING SHARKS.

Sharks of immense size with the gill-openings extremely wide, extending from the back nearly to the median line of the throat, all of them in front of the pectorals; mouth moderate, the teeth very small, numerous, conical, without cusps or serratures; no nictitating membrane; spiracles very small, above the corners of the mouth; first dorsal large, midway between pectorals and ventrals; second dorsal and anal small; caudal fin lunate, the upper lobe considerably the larger; caudal peduncle keeled; pectorals and ventrals large. Brain very small. A single genus, with probably but one species; the largest of living fishes, pelagic, and inhabiting the northern seas.

21. CETORHINUS Blainville.

? *Tetroras* Rafinesque, Caratteri, 1810, p. 11 (*angiora*).
Cetorhinus Blainville, Journ. Phys., 1816, p. 264 (*gunneri=maximus*).
Selache Cuvier, Règne Animal, 1st ed., 1817, p. 129 (*maximus*).
Polyprosopus Couch, Hist. Brit. Fish., I, 1861, p. 67 (*rashleighanus=maximus*).
Hannovera Van Beneden, Bull. Ac. Roy. Belge, XXXI, 1871, p. 504 (*aurata*, fossil).

The characters of the genus are included above.

(κῆτος, whale; ῥίνη, a shark (Squatina), from ῥίνη, a file or rasp, the rough skin of this shark being used for polishing wood and marble.)

23. CETORHINUS MAXIMUS (Gunner).

UBAZAME (OLD WOMAN SHARK); TEGUZAME (LONG-NOSED SHARK); BAKAZAME (FOOLISH SHARK); ZOZAME (ELEPHANT SHARK).

Squalus maximus Gunner, Trondhjem, Selskabskr., III, 1765, p. 33; Coast of Norway.
Selachus maximus Storer, Fish. Mass., 1867, p. 229.
Selache maximus Günther, Cat. Fish., VIII, 1870, p. 394.
Cetorhinus maximus Jordan and Gilbert, Synopsis, 1883, p. 31.—Jordan and Evermann, Fish N. M. Amer., I, 1896, p. 51.
Squalus gunnerianus Blainville, Journ. de Phys., 1810, p. 256 (after Gunner).
Squalus pelegrinus Blainville, Journ. de Phys., 1810, p. 257; Europe.
Squalus homianus Blainville, Journ. de Phys., 1810, p. 257 (after Everard Home).
Cetorhinus shavianus Blainville, Journ. de Phys., 1816, p. 264 (after Shaw).

Squalus isodus SAVERIO MACRI, Mem. della R. Ac. Sci. Napoli, I, 1819, p. 55, pl. I, fig. 1; pl. II, fig. 2; Naples.

Squalus elephas LE SUEUR, Journ. Ac. Nat. Sci. Phila., II, 1821, p. 343; New Jersey.

Squalus cetaceus GRONOW, Cat. Fish, 1854, p. 6; Norway.

Squalus rashleighanus COUCH, Trans. Linn. Soc., XIV, 1825, p. 91; Cornwall (a monstrosity).

Acanthias blainvillei CAPELLO, Plagiostom., I, 1866, p. 21.

Polyprosopus macer COUCH, Hist. Brit. Fishes, 1861, p. 67; England.

Head small; snout blunt; eyes small; teeth in 6 or 7 rows in each jaw, about 200 in each row. Gill-rakers slender, long and close set, resembling whalebone. Body rugose, the skin very rough with small spines. First dorsal large, triangular, over the space between pectorals and ventrals; second dorsal much smaller, rather larger than anal; pectorals long; tail large. Largest of the sharks, reaching a length of nearly 40 feet. (Jordan and Evermann.)

Found in Arctic seas and occasionally off the coast of Japan. It is figured by Dr. Matsubara in the colored plates of The Principal Aquatic Animals of Japan, under the name of "Ubazame." No specimens were seen by us in Japan.

(*maximus*, greatest.)

Family XII. RHINEODONTIDÆ.

WHALE SHARKS.

Very large sharks, formed much as in *Cetorhinus*, the caudal lunate, with well-developed lower lobe and a keel on each side of the tail. Origin of first dorsal in advance of ventrals; second dorsal small, opposite anal; no spines, no nictitating membrane, snout broad and flat; eyes very small; spiracles very small, mouth and nostril near extremity of snout. Teeth conical, or with a heel at base, very small and numerous. Gill-openings wide, the last one above the base of the pectorals. Species very few, mostly in the Pacific.

22. RHINEODON Smith.

Rhineodon ANDREW SMITH, Illustr. S. Afr. Fishes, 1837 (*typicus*).

Micristodus GILL, Proc. Ac. Nat. Sci. Pnila., 1865, p. 177 (*punctatus*).

Rhinodon GÜNTHER, revised spelling (*typicus*).

Teeth conical, very small. Characters otherwise included above.

(ῥίν, snout; ὀδούς, tooth.)

24. RHINEODON TYPICUS Smith.

? *Rhineodon typicus* SMITH, Illustr. S. Afr. Fish, 1837; Cape of Good Hope.

? *Micristodus punctatus* GILL, Proc. Ac. Nat. Sci. Phila., 1865, p. 177; Gulf of California.

Rhinodon pentalineatus KISHINOUYE, Zool. Anzeiger, Nov. 25, 1891, p. 694; Cape Inubo, Japan.

A gigantic shark from Japan has been described by Dr. Kishinouye under the name of *Rhinodon pentalineatus*. It is apparently a species of *Rhineodon*, but it is impossible to say whether it is different from *Rhineodon typicus* or *Rhineodon punctatus*, or whether these two nominal species differ from each other. *Rhineodon typicus* is widely diffused in the tropical seas and has been lately taken in Florida, a record having been published by Mr. Barton A. Bean. It is probably the only species of the genus. The following is Dr. Kishinouye's description:

Head flat, blunt; eyes very small, situated on sides of head near margin of colored area; nictitating membrane wanting; mouth nearly straight, terminal; a labial fold runs from nostril to corner of mouth on upper jaw, and shorter fold from corner of mouth on lower jaw; teeth very minute, numerous, nearly equal in size and shape, each acutely pointed, laterally compressed, and with an ellipsoidal root; band of teeth in upper jaw curved a little, each end of band with a detached group of teeth, band in lower jaw crescent shaped, and in each band arranged in a great many transverse rows, about 300 in number, middle part of band with 16–30 teeth in one row; nostrils at anterior extremity of head, and opening at labial boundary of mouth. Gill-openings 5, very wide, the second pair widest, measuring 86 cm., last pair most narrow, opening above base of pectorals, where body is very broad and high. Spiracles nearly same size as eye and on the same level.

Skin fine grained, except five longitudinal smooth bands, one dorsal median, two pairs lateral; ventral lateral band seems to be continuous with keel on each side of tail.

First dorsal fin inserted a little behind middle of body; second dorsal fin very small; anal very small, just below second dorsal; pectorals large, strong; ventrals inserted below first dorsal; caudal large, lunate, its ventral lobe well developed; clasper simple, with dorsal groove.

Color grayish brown, with round white spots and transverse bands, ventral side colorless; round white spots small and crowded near anterior end of body, gradually larger and fewer backward; caudal, second dorsal, ventrals, and anal destitute of white markings.

Length at present 800 cm., in circumference behind pectorals, 365 cm. (stuffed specimen), but when fresh measuring nearly 1,000 cm.

Taken in a drift net June 10, 1901, off Cape Inubo; now in the collection of Tsurutame Oseko of Asakusa Park, Tokyo. (Kishinouye.)

The Japanese form is known only from the example described above. When taken it was covered with many sucking fishes (*Echeneis*), and one, besides an oak pole, was taken from its stomach. It is said to differ from *Rhinodon typicus* Smith and *Micristodus punctatus* Gill in the form of the teeth and the labial fold. But it is impossible to distinguish species in this genus until its members are better known.

(*typicus*, typical.)

Order III. TECTOSPONDYLI.

Calcareous lamellæ arranged in one or more concentric series or rings about a central axis in each vertebra. Spiracles present. Anal fin wanting. Dorsal fins 2, with or without spine. As here understood, the order *Tectospondyli* includes the sharks of the groups called *Cyclospondyli* and *Tectospondyli* by Hasse. The vertebræ in the order of Rays show similar structures, and it is probable that from sharks of this group the Rays are descended.

(τέκτων, builder; σπόνδυλος, vertebra.)

FAMILIES OF TECTOSPONDYLI.

a. CYCLOSPONDYLI: Vertebræ with calcareous lamellæ arranged in a ring about the central axis; pectoral fins normal, not expanded or deeply notched; anal fin absent; spiracles present, no nictitating membrane; gill-openings before pectorals; caudal bent upward, lower lobe little developed.

b. Dorsal fins each provided with a stout spine, first dorsal far in advance of ventrals ---------- SQUALIDÆ, XIII.

bb. Dorsal fins without spine, first dorsal over or in advance of ventrals.

c. Snout not produced in form of a saw; no barbels; first dorsal much before ventrals; skin moderately rough ---------- DALATIIDÆ, XIV.

cc. Snout produced in a long, flat blade, with sharp, saw-like teeth on each side; a pair of barbels below snout; first dorsal before ventrals.
PRISTIOPHORIDÆ, XV.

aa. TECTOSPONDYLI: Vertebræ with calcareous lamellæ ranged in several concentric series or rings about a central axis; pectoral fins very large, expanded horizontally, and extended forward at base in front, giving body the form of the flattened disk of rays; anterior extension separated from neck by a deep notch, in which gill-openings lie; no anal fin; dorsal fins small, posterior; mouth broad, anterior ---------- SQUATINIDÆ, XVI.

Family XIII. SQUALIDÆ.

DOG-FISHES.

Body more or less elongate. Head depressed. Eyes lateral, without nictitating membrane. Mouth inferior, rather large, arched, a deep groove on each side. Teeth compressed, variously formed. Nostrils inferior, separate; spiracles rather large; gill-openings moderate, all in front of the pectoral fins. Dorsal fins 2, each armed with a spine; the first dorsal in front of the ventrals; anal fin wanting; caudal fin with the lower lobe small or obsolete, ventral fins inserted posteriorly, not much before second dorsal. Oviparous. Genera 6 or more; species about 15; rather small sharks, chiefly of the Atlantic. These sharks represent a comparatively primitive type, apparently not descended from any other existing *Squali*.

a. Body rather elongate; no fold of skin along side of belly; dorsal spines both directed backward.

b. Upper teeth simple, without smaller cusps at base.

c. Teeth alike in both jaws, subquadrate, each with a nearly horizontal oblique cutting edge and a point directed outward ....*Squalus*, 23.

cc. Teeth unequal; upper teeth erect, with a single cusp; lower teeth more or less oblique, points directed outward; dorsal spines not hidden.

d. Scales leaf-shaped, with a strong midrib, and sometimes a lateral rib on each side, attached by a peduncle; dorsal spines strong. *Lepidorhinus*, 24.

dd. Scales not leaf-shaped and not pedunclate at base.

e. Scales not imbricate, each of three or four radiating spinules; dorsal spines strong ....*Deania*, 25.

ee. Scales imbricate, each with three or more strong ribs, each ending in a spine, the middle strongest; dorsal spines short ....*Zameus*, 26.

bb. Upper teeth each with 1 or 2 small cusps at base on each side.

f. Teeth unequal, upper erect and tricuspid, lower oblique. *Etmopterus*, 27.

ff. Teeth equal, very small, and tricuspid in both jaws..*Centroscyllium*, 28.

23. SQUALUS Linnæus.

Squalus LINNÆUS, Syst. Nat., X, 1758, p. 233 (*acanthias*, first species named; includes all sharks).

Squalus RAFINESQUE, Caratteri di Alcuni Generi, 1810, p. 13 (*acanthias* and *uyato;* first restriction of the name *Squalus* to species with spiracles and without anal fin).

Acanthorhinus BLAINVILLE, Journal de Physique, 1816, p. 263 (*acanthias*).

Acanthias RISSO, Hist. Nat. Eur. Mérid., III, 1826, p. 131 (*acanthias*).

Entoxychirus GILL, Proc. Ac. Nat. Sci. Phila., 1862, p. 496 (*uyato*).

Body rather slender. Mouth little arched, with a long, straight, deep, oblique groove on each side; no labial fold. Teeth rather small, all simple, equal in the two jaws, their points so much turned aside that the inner margin forms the cutting edge. Spiracles rather wide, just behind the eye. Fins moderately developed, the first dorsal larger than the second, much in advance of the ventral fins, which are behind the middle of the body, although in advance of the second dorsal. Dorsal spines strong, not grooved. Tail scarcely bent upward. Small sharks, abounding in the temperate seas.

(*squalus*, shark, a word cognate to the Greek *γαλή*.)

25. SQUALUS MITSUKURII Jordan and Snyder, new species.

TSUNOZAME (HORN SHARK); TSUNOGE (HORNY FISH).

Squalus mitsukurii JORDAN and SNYDER, Check List, 1901, p. 129; Misaki, name only.

Head about $4\frac{3}{5}$ in body; width of head $1\frac{1}{5}$ in its length; snout $2\frac{3}{5}$, interorbital space 2; width of mouth $2\frac{1}{3}$; tip of snout to mouth 2; eye $2\frac{2}{3}$ in interorbital space.

Body moderately elongate, tail tapering moderately behind. Head broad, depressed, flattened above; snout pointed in profile, when viewed from above angular, tip rather broadly rounded, and upper surface flattened; eyes rather large, lateral, a little nearer tip of snout than

first gill opening; mouth very broad, slightly curved, a deep labial fold at each corner; lips thin; teeth moderate, forming a cutting edge in each jaw; nostrils rather large, inferior, while nearer eye than tip of snout they are nearer the latter than mouth; interorbital space is broad, very elevated, flattened more or less like upper surface of head. The spiracles large, directly behind eye. Gill-openings in front of base of pectoral.

Body everywhere finely roughened.

Origin of first dorsal spine a trifle nearer tip of snout than that of second dorsal; first dorsal spine is three-fifths height of fin; spine of second dorsal three-fourths height of fin; pectorals large, smaller than head, reach beyond base of first dorsal, emarginate behind; ventrals nearer second dorsal than first; caudal broad, lower lobe rather long. Caudal peduncle rather long, with a pit at base above. Lateral line indistinct along side.

Color in alcohol gray above, white beneath; upper surface of pectorals and ventrals grayish.

Length $28\frac{1}{2}$ inches.

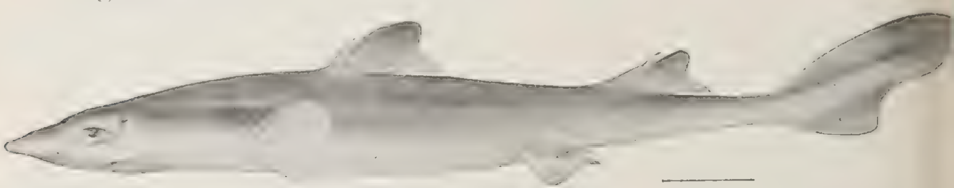


FIG. 3.—SQUALUS MITSUKURII.

Type No. 7184, Ichthyological Collections, Leland Stanford Junior University Museum. Locality, Misaki.

Coasts of Japan, generally common from Hokkaido as far southward as Formosa. Numerous large adults taken at Misaki, one of them the type, a female. Several embryos were also obtained, part of them from this specimen. A young example was also obtained from near Aomori in Tsugaru Straits, and another one, probably of the same species, from Formosa. Specimens are in the Imperial Museum from Kagoshima, and Boshu in Awa near Misaki. These are recorded by Ishikawa[a] as *Acanthias vulgaris* and *A. uyatus*, but the two specimens are alike.

(Named for Prof. Kakichi Mitsukuri, who was present with Messrs. Jordan and Snyder at Misaki, when the type was taken.)

24. LEPIDORHINUS Bonaparte.

Lepidorhinus BONAPARTE, Selach. Tab. Analyt., 1836, p. 9 (*squamosus*).
Scymnodon BOCAGE and CAPELLO, Proc. Zool. Soc. Lond., 1864, p. 263 (*ringens*)
Machephilus JOHNSON, Proc. Zool. Soc. Lond., 1867, p. 713 (*dumerili*).

This genus is close to *Centrophorus*, differing in the form of the scales, which are leaf-shaped and pedunculate, with a strong median

[a] Prel. Cat., p. 61.

keel which ends in a point. The single Japanese species belongs to the subgenus *Scymnodon*, characterized by the presence of three keels, the scale ending in three points.

(λεπίς, scale; ῥίνη, shark.)

26. LEPIDORHINUS FOLIACEUS (Günther).

Centrophorus foliaceus GÜNTHER, Deep Sea Fishes, Challenger, 1887, p. 5, pl. II, fig. A (off Enoshima).

Head $4\frac{3}{5}$ in body; width of head $1\frac{1}{2}$ in its length; snout $3\frac{1}{3}$; interorbital space 2; width of mouth $2\frac{1}{2}$; snout to mouth $1\frac{5}{7}$; space between spiracles 3; eye about $1\frac{3}{4}$ in interorbital space.

Body rather elongate, tail tapering. Head elongate, depressed, broad; snout broad, flattened, tip broadly rounded; eyes large, lateral, nearer snout than gill-opening; mouth rather small, slightly curved, with deep labial fold at each corner; lips thin; teeth forming cutting edges in jaws, those in lower jaw with several small cusps; nostrils large, inferior, nearer eye than tip of snout, and nearer latter than mouth; interorbital space broad, flattened. Spiracles large, round, space between one and one-half in interorbital space. Gill-openings low, in front of pectorals.

The body covered with large leaf-shaped scales, 3 pointed, keeled in front and on a pedicle; they are large on trunk, both above and below, but especially enlarged in front of first dorsal.

Both dorsals provided with sharp spines, with only the tips exposed; origin of first dorsal nearer tip of snout than base of second, and a short distance behind base of pectoral; pectoral short, truncate, less than two in head; ventrals small, in front of second dorsal, nearer tip of caudal than tip of snout; caudal four and one-fourth in body. Caudal peduncle short, its depth three in interorbital space.

Color in alcohol uniform gray brown, edges of nostril and lower lips blackish.

Length $14\frac{1}{4}$ inches.

Described from a specimen from Misaki, taken in deep water by K. Aoki.

Deep waters off Japan, known only from off Enoshima and Misaki in Sagami Bay. Our specimen is from near Misaki.

(*foliaceus*, leaf-like.)

25. DEANIA Jordan and Snyder.

Deania JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXV, 1902, p. 80 (*eglantina*).

Scales minute, villous, each star-like, and with three or four long points. The skin velvety to the touch. Snout long, flattish. Dorsal spines strong. In other regards similar to *Centrophorus*, but the squamation quite different.

(Named for Prof. Bashford Dean, of Columbia University, in recognition of his researches in sharks, those of the present genus among others.)

27. DEANIA EGLANTINA Jordan and Snyder.

Deania eglantina Jordan and Snyder, Proc. U. S. Nat. Mus., XXV, 1902, p. 80; Totomi Bay.

Head $3\frac{3}{4}$ in length; depth about $9\frac{2}{3}$; snout about 2 in head; eye $4\frac{6}{7}$; $2\frac{6}{7}$ in snout; 2 in width of snout; $3\frac{5}{7}$ in space from tip of snout to mouth; space between spiracles $1\frac{2}{3}$ in width of snout.

Body rather elongate, slender; scales each with short, bush-like spines, with two small prickles on each side, whole body having a kind of hairy appearance.

Head large, greatly depressed; snout long, depressed, broad; eyes large, lateral, anterior margin nearer tip of snout than gill-opening; skin around eyes more or less loose, free; nostrils large, on lower side of snout laterally, about midway between tip of snout and eye; mouth opening below posterior part of eye, rather broad; lips moderately fleshy; teeth small, compressed, with a small basal cusp; spiracles rather large, nearer eye than first gill-opening, space between a little more than length of snout. Gill-openings in front of base of pectoral, largest about half eye.

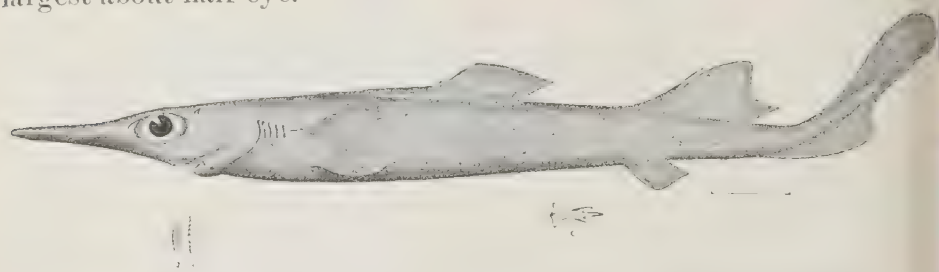


Fig. 4.—Deania eglantina. *a*, upper jaw; *b*, lower jaw; *c*, scale (much enlarged.)

Dorsal fins each with a spine, base of first a little behind tip of pectoral, rather short, sharply pointed, and projecting little above skin; second dorsal spine nearly as high as fin, upper half exposed; pectorals about equal to snout; ventrals small, posterior, entirely in front of second dorsal spine; caudal elongate, lower lobe little produced.

Color in spirits, uniform grayish-brown.

This description from the original type, a young female from Totomi 12 inches in length, dredged by the U. S. Fish Commission steamer *Albatross*.

(*eglantinus*, the brier rose.)

26. ZAMEUS Jordan and Fowler, new genus.

Zameus Jordan and Fowler, new genus (*squamulosus*).

Dorsal fins each with a small, partly concealed spine; no anal fin; mouth wide, little arched; a long, deep, straight, oblique groove o

ach side of mouth; teeth of lower jaw oblique, with the points directed more or less outward of backward; upper teeth erect, triangular or lanceolate, with a single cusp. No nictitating membrane; spiracles wide behind the eye; gill-openings narrow; scales not leaf-shaped, nor pedimaculate, each with a strong median keel and two or more lateral keels, each of these ending in a spine. In *Centrophorus*, the nearest related genus, there is no midrib to the scales, which are nearly smooth. In *Centroscymnus* the scales are smooth with a depression at the base. Small sharks, living in deep water.

(*zame*, shark, in Japanese.)

28. ZAMEUS SQUAMULOSUS (Günther).

Centrophorus squamulosus GÜNTHER, Deep Sea Fish, Challenger, 1887, p. 5, pl. II, fig. B; Enoshima.

Snout much produced, mouth nearly midway between first gill-opening and end of snout; labial fold extends a little way along margins of mouth; upper lip fringed; distance between nostrils two-fifths of length of preoral portion of snout. Scales tricuspid, with a median keel, and so minute as to give a velvety appearance to skin. First dorsal small, its base (without spine) shorter than that of second, nearly one-sixth of distance between two fins; spines very small, scarcely projecting beyond skin; pectoral short, with lower angle rounded, not produced; extremity of ventral fins below end of second dorsal. Uniform deep black. Length, 27 inches. Off Inosima, Japan, Station 232 (Challenger) in 345 fathoms. (Günther.)

Coasts of Japan, in rather deep water. Known only from Sagami Bay, about Enoshima (misspelled Inosima by Günther) and Misaki, where our specimen was taken.

(*squamulosus*, with small scales.)

27. ETMOPTERUS Rafinesque.

Etmopterus RAFINESQUE, Caratteri di Alcnui Generi, 1810, p. 14 (*aculeatus*).
Spinax CUVIER, Règne Animal, 1st ed., 1817, p. 129 (*acanthias* and *spinax*).
Spinax MÜLLER and HENLE, Plagiostomen, 1838, p. 86 (*spinax*).
Acanthidium LOWE, Proc. Zool. Soc. London, 1839, p. 91 (*pusillum*).

Mouth little arched. Teeth of lower jaw with the point so much turned aside that the inner margin of the tooth forms the cutting edge; upper teeth erect, each with a long, pointed cusp and 1 or 2 smaller ones on each side; spiracles wide.

Small sharks of the warm seas, living in deep water, and nearly black in color.

(ἔτμαγεν, an aorist from τέμνω, to cut; πτερόν, fin, the original type having frayed fins.)

29. ETMOPTERUS LUCIFER Jordan and Snyder.

BOZUZAME (PRIEST SHARK).

Etmopterus lucifer JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXV, 1902, p. 7 (Misaki).

Head $4\frac{3}{4}$ in length; depth about 7; snout about $2\frac{3}{4}$ in head; eye $5\frac{2}{5}$ in head; 2 in snout; $2\frac{4}{11}$ in width of snout; $2\frac{9}{11}$ in space from tip of snout to mouth; space between spiracles $2\frac{1}{2}$ in width of snout.

Body moderately elongate, rather robust, with slender caudal peduncle; scales forming longitudinal striæ above, abruptly and sharply separated on sides from lower surface, which is evenly rough with fine shagreen.

Head large, thick, rather short; snout short, thick, more convex below than above, also with many pores; eyes moderate, lateral, anterior margin midway between tip of snout and spiracle; skin about eyes, more or less loose, free, upper eyelid overlapping and forming a pit in front; nostrils very large, lateral; mouth opening below posterior portion of eye, broad; lips rather thin; teeth small, compressed, each of those in upper jaw with two sharp, basal cusps; spiracle

FIG. 5.—ETMOPTERUS LUCIFER. *a*, upper jaw; *b*, lower jaw.

large, nearer eye than first gill-opening, space between $1\frac{1}{4}$ in snout. Gill-openings in front of base of pectorals, rather short.

Dorsal fins each with a spine, base of first a little before tip of pectoral, short, sharp, pointed, projecting little above skin; second dorsal spine not as high as fin, much larger, longer than first, the greater portion exposed, and nearly a third greater than snout; ventrals moderate, entirely in front of second dorsal; caudal elongate, lower lobe little produced.

Color in spirits, dark grayish-brown, lower margin of caudal together with marginal portions of all other fins, very pale brown.

Length, 12 inches.

Type No. 6863, Ichthyological Collections, Leland Stanford Junior University. Locality, Misaki. From the collection of Capt. Alan Owston.

Some 30 others of the same species were obtained off Misaki on long lines handled by Mr. Kumakichi Aoki, assistant to Professor Mitsukuri.

The pale areas on the side of the belly cover a glandular substance said to be luminous in life.

(*lux*, light; *fero*, to bear; the thickened skin of the belly said to be translucent.)

28. CENTROSCYLLIUM Müller and Henle.

Centroscyllium Müller and Henle, Systematische Beschreibung der Plagiostomen, 1838, p. 191 (*fabricii*).

Teeth equal in both jaws, very small, straight, pointed, each with 1 or 2 smaller cusps on each side at base; mouth crescent-shaped, with a straight, oblique groove at its angle; spiracles moderate; gill-openings rather narrow; dorsal fins small, each with a strong spine; the second dorsal entirely behind the ventrals.

(*κέντρον*, spine; *σκυλλίον*, *Scyllium*, an allied genus, from *σκύλλω*, to rend or tear to pieces.)

30. CENTROCYLLIUM RITTERI Jordan and Fowler, new species.

Head $5\frac{1}{2}$ in length; snout about $3\frac{3}{4}$ in head; interorbital space 2; width of mouth 2; eye about 5; space between spiracles $2\frac{1}{3}$; pectoral about 2.

Body elongate; head very broad and depressed, flattened above; snout short, very broad, flattened above, rounded; eye large, near snout; nostrils large, inferior, midway between tip of snout and eye;

Fig. 6.—Centrocyllium ritteri.

mouth distant from tip of snout a space equal to a trifle more than interorbital width; teeth very sharp, tricuspid, alike both jaws; lips rather thin, a labial fold at corners of mouth; interorbital space broad, greater than space between spiracles. Spiracles large, superior, behind eyes.

Body covered with small, single prickles, scattered, though not present on lower surface of snout, small on lower abdominal surface. Head with many pores, especially on lower surface of snout.

First dorsal spine smaller than second, slightly more than half height of fin; second dorsal spine long, curved, but not quite to tip of fin; origin of first dorsal nearer that of second than the tip of snout, inserted well behind pectoral; second dorsal nearer first dorsal than tip of caudal, tip of fin anteriorly not extending for more than half the space between its base and origin of upper caudal lobe; pectoral fins broad, short, about equal to width of snout in front of eyes; ventrals small and entirely in front of second dorsal; caudal moderate, less than space between two dorsal spines. Caudal peduncle long, rather slender, thick, flattened above and below. Lateral line with pores, rather far apart, running superiorly in front and along sides.

Color, uniform dark gray-brown, blackish below, in front, fins all more or less broadly edged with whitish. Length 16½ inches.

Type No. 7185, Ichthyological Collections, Leland Stanford Junior University Museum. Locality, Misaki.

This species is known to us from 2 examples obtained at Misaki. It differs from *Centroscyllium fabricii*, the only other species of the genus, in having the caudal peduncle much longer and more slender, and in the shorter pectorals, which do not reach to below the first dorsal.

(It is named for Dr. William Emerson Ritter, of the University of California, in recognition of his excellent work on the Tunicates and Enteropneustans of the Pacific Ocean.)

Family XIV. DALATIIDÆ.

SCYMNOID SHARKS.

Sharks with no anal fin and with two dorsal fins, each without spine; gill-openings small, entirely in advance of pectorals; mouth but little arched; a long, deep, straight, oblique groove on each side; spiracles present. Oviparous, the eggs without horny case (at least in *Somniosus*). Vertebræ cyclospondylous. The absence of dorsal spine chiefly distinguishes this family from the *Squalidæ*, of which these are somewhat degenerate allies. Sharks mostly of the North Atlantic, some of them reaching a large size.

a. DALATIINÆ: First dorsal well behind ventrals; upper teeth small, pointed, lower much larger, triangular .... *Dalatias*, 29.

aa. SOMNIOSINÆ: First dorsal much in advance of ventrals.

b. Upper teeth narrow; lower quadrate with a horizontal edge ending in a point directed outward; body very robust, fins very small, dorsals about equal; skin moderately rough .... *Somniosus*, 30.

29. DALATIAS Rafinesque.

Dalatias RAFINESQUE, Caratteri di Alcuni Generi, 1810, p. 13 (*sparophagus*; description very incorrect).

Scymnus CUVIER, Règne Animal, 1st ed., 1817, p. 130 (*lichia*; preoccupied in insects).

Scymnorhinus BONAPARTE, Cat. Pesci. Europ., 1836, p. 16 (*lichia*).

Mouth transverse, a deep straight groove at each angle. Teeth in jaws close set, the upper small, pointed; the lower much larger, dilated, erect, triangular, not very numerous. Skin uniformly covered with minute scales. Two short dorsal fins, without spine, the first at a considerable distance from the ventrals; no anal fin. No membrana nictitans. Spiracles wide. Gill-openings narrow. (Günther.)

(δάλος, torch, the name unexplained.)

31. DALATIAS LICHA (Bonnaterre).

YOROIZAME (ARMOR SHARK).

Squaleus licha[a] Bonnaterre, Encycl. Ichth., 1788, p. 12 (after La Liche ou Gatto, Broussonet, Mem. Ac. Sci., 1788, p. 677; "Le Cap Bréton," in southern France).

Scymnorhinus licha Garman, Deep Sea Fishes, 1899, p. 31.

Squalus americanus Gmelin, Syst. Nat., 1788, p. 1503 (after Broussonet, "Cap Bréton" being assumed to be in Nova Scotia).

Acanthorhinus americanus Blainville, Fauna Française, 1828, p. 63, pl. xv, fig. 2.

Squalus nicæensis Risso, Ichth. Nice, 1810, p. 43, pl. iv, fig. 6; Nice.

Dalatias sparophagus Rafinesque, Caratteri di Alcuni Generi, 1810, p. 13; Palermo (description very incorrect, but certainly referring to this species).

Scymnus lichia Cuvier, Règne Animal, 1st ed., 1817.—Duméril Elasmobranches, 1870, p. 452; Mediterranean.—Günther, Cat. Fish, VIII, 1870, p. 426; Nice; Madeira (and of writers generally).

Dalatias lichia Gray, Chondropt., 1851, p. 75.

Snout rather projecting, anterior edge of mouth before front of eye; teeth of upper jaw narrow, lanceolate, close-set; lower teeth triangular, margins somewhat convex and slightly serrate. Skin covered with a shagreen of fine, sharp, close-set spinous scales. First dorsal inserted nearer pectorals than ventrals by a distance equal to length of pectoral; second dorsal a little before posterior end of base of ventrals; distance from second dorsal to beginning of caudal, $2\frac{1}{2}$ in distance between dorsals. Color black. Length 650 mm. ($25\frac{1}{2}$ inches).

This incomplete description is from a stuffed specimen[b] in the Imperial Museum in Tokyo. The specimen, being hastily compared with Müller and Henle's figure, showed no evident difference, though its relations may appear on close examination.

Mediterranean Sea and neighboring waters, and, as above recorded, once taken in Japan.

(*licha*, the meaning of the name unexplained.)

30. SOMNIOSUS Le Sueur.

Somniosus Le Sueur, Jour. Ac. Nat. Sci. Phila., 1818, I, p. 222 (*brevipinna*=*microcephalus*).

Leiodon Wood, Proc. Bost. Soc. Nat. Hist., II, 1847, p. 174 (*echinatum*=*microcephalus*).

Læmargus Müller and Henle, Plagiostomen, 1838, p. 93 (*borealis*=*microcephalus*).

Rhinoscymnus Gill, Proc. Ac. Nat. Sci. Phila., 1864, p. 264 (*rostratus*).

Body thick and clumsy; mouth transverse, little arched, with a deep, straight groove running backward from its angle; nostrils near the extremity of the snout; jaw feeble; teeth in upper jaw small, narrow, conical; lower teeth numerous, in two or more series, the point so

[a] The name *licha*, of the same date as *americanus*, is much less inappropriate.
[b] Ishikawa, Prel. Cat., p. 61, as *Scymnus lichia*.

much turned aside that the inner margin forms a cutting edge, which is entire; spiracles moderate; no nictitating membrane; gill-openings narrow; fins all very small, the ventrals between the dorsal fins; skin uniformly covered with minute tubercles. Tail short, much bent upward. Eggs large, soft, globular, without shell, dropped in the ooze on the sea bottom. Species of the northern seas.

(*somniosus*, sleepy.)

32. SOMNIOSUS MICROCEPHALUS Bloch and Schneider.

Squalus microcephalus Bloch and Schneider, Syst. Ichth., 1801, p. 135, northern seas.

Somniosus microcephalus Jordan and Evermann, Fish North and Middle Amer., I, 1896, p. 57.

Somniosus brevipinna Le Sueur, Jour. Ac. Nat. Sci. Phila., I, 1818, p. 122; Massachusetts.

Scymnus brevipinna Storer, Fishes Mass., 1867, p. 235.

Squalus borealis Scoresby, Arct. Reg., I, 1820, p. 538, pl. xv, figs. 3 and 4; Arctic Ocean.

Læmargus borealis Günther, Cat. Fish., VIII, 1870, p. 426.

Squalus glacialis Faber, Fische Isl., 1829, p. 23; Iceland.

Squalus norwegianus Blainville, Faune Française, 1828, p. 61; Norway.

Leiodon echinatum Wood, Proc. Bost. Soc. Nat. Hist., II, 1847, p. 174. Massachusetts.

Body robust, rapidly tapering behind; greatest depth little more than one-fifth length; head somewhat less; mouth moderate, upper jaw with 5 rows of small, sharp teeth, which are incurved, lanceet-shaped; lower jaw with 2 rows of broad, quadrangular teeth, divided in their centers by perpendicular ridge, directed outward, about 26 teeth on each side; fins small, first dorsal about as large as ventrals, larger than second dorsal; pectorals short, caudal short, bluntish. Length about 25 feet. Arctic seas south to Cape Cod, Oregon, France, and Japan.

A huge, clumsy shark, not rare northward; an enemy to the whales, biting out large masses of flesh from their bodies.

The only Japanese record is that of a large example, seen by Jordan and Snyder in the market of Tokyo, in June, 1900. Specimens from the Pacific have never been compared with those from the Atlantic, and may belong to different species.

(μικρός, small; κεφαλή, head.)

Family XV. PRISTIOPHORIDÆ.

SAW SHARKS.

Body elongate, covered with fine, smoothish scales, forming shagreen; snout produced in a long, flat blade, with sharp teeth on each side projecting at right angles, these of unequal lengths; a pair of barbels on

lower part of snout near its middle; teeth small, close-set, each with a sharp cusp on a broad base; nostrils inferior, with conspicuous valves; eyes large, no nictitating membrane; spiracles large; pectorals rather large, distant from head; first dorsal in front of ventrals; second dorsal large; no dorsal spine; no anal fin; gill-openings moderate, all before pectoral; lower caudal lobe narrow. Species few; found from Japan to Australia, resembling the saw fishes (*Pristidida*) of the New World, but smaller in size and different in details of structure.

31. PRISTIOPHORUS Müller and Henle.

Pristiophorus MÜLLER and HENLE, Plagiostomen, 1838, p. 97 (*cirratus*).

Characters of the genus included above.
(*πρίστις*, saw; *φορέω*, to bear.)

33. PRISTIOPHORUS JAPONICUS Günther.

NOKOGIRIZAME (SAW SHARK); HOKABUKA (HALBERD SHARK); DAIGIRIZAME (SAW SHARK).

Pristiophorus cirratus SCHLEGEL, Fauna Japonica, Poiss., 1847, p. 105, pl. CXXXVII; Nagasaki.—RICHARDSON, Ich. China, 1846, p. 317.—BLEEKER, Nieuwe Nalezing, Ichth. Jap., 1854, p. 128; Nagasaki (not of Latham, 1794).

Pristiophorus japonicus GÜNTHER, Cat. Fish, VIII, 1870, p. 43; Japan.—ISHIKAWA, Prel. Cat., 1897, p. 61; Sagami Bay.

Head a trifle less than 3 in body; tip of snout to eye $3\frac{3}{4}$ in head; greatest width of head $4\frac{3}{5}$ in its length; interorbital space $8\frac{2}{5}$ in head; spiracle $2\frac{2}{3}$ in interorbital space; eye $1\frac{2}{3}$; pectoral 3 in head; height of first dorsal $4\frac{1}{6}$; caudal $2\frac{1}{3}$.

Body elongate, moderately thick. Head small, except for elongate depressed snout, or saw, greatly depressed and flattened, both above and below; saw rather broad, thin, becoming narrow at tip, truncately rounded; in each margin of saw a series of sharp teeth of uneven size, the larger with one, two, or three smaller between; on lower marginal surface of snout a single series of small, backwardly hooked teeth, each at some distance apart; in lower surface of saw, near edges, a pair of flattened tentacles about equal in length to width of head in front of eyes; teeth on edge of saw become smaller posteriorly and extend halfway in space between eye and first gill-opening; mouth broadly obtuse below posterior part and behind eye; teeth small, pointed, in many rows in jaws; nostrils are a trifle closer together than corners of mouth, nearer latter than tentacles, or about in last third of space between; interorbital space more or less flattened, though there are slight supraocular ridges; eye elongate, lateral, placed less than its diameter posterior to nostrils. Spiracles very large, half the eye, placed directly behind its posterior margin. Gill-openings moderate, in front of base of pectoral.

Entire body finely roughened.

Origin of first dorsal nearer tip of caudal than tip of saw, nearer origin of ventral than that of pectoral, nearer posterior margin of eye than second dorsal; two dorsals are similar, of about equal size, second with posterior part of its base midway between first dorsal and tip of caudal; pectorals large, broad, blunt, rounded, nearer origin of second dorsal than tip of saw; ventrals behind first dorsal and nearer origin of second dorsal than that of pectorals; caudal not very broad, upper lobe much broader than lower, whole fin a little more than space between dorsals. Caudal peduncle rather long, thick, flattened above and below, its least depth one and one-half in interorbital space. A lateral keel along each side of tail from ventrals to caudal inferiorly. No pores in lateral line.

Color, pale gray-brown above; below, whitish.

Length, 40¼ inches.

This description from a large example from Aomori.

Coasts of Japan; our specimens from Aomori and Nagasaki, the latter received from Mr. Yahiro. A specimen is in the museum of Aomori, taken at Ajigasawa on the Japanese Sea.

The teeth are placed somewhat differently from those represented in Schlegel's figure, but the species is doubtless the same.

Family XVI. SQUATINIDÆ.

ANGEL SHARKS.

Ray-like sharks. Body depressed and flat, the snout obtuse, the mouth anterior; teeth conical, pointed, distant; pectoral fins very large, expanded in the plane of the body, but not adherent to the side of the head, being deeply notched at the base; ventral fins very large; dorsal fins 2, small, subequal, on the tail behind the ventrals; no anal fin; caudal small; gill-openings wide, partly inferior, partly hidden by the base of the pectoral; spiracles wide, crescent-shaped behind the eyes; nostrils on the front margin of the snout, with skinny flaps; males with small prehensile appendages; vertebræ tectospondylous. A single genus among living forms, with but one species certainly known; a small shark of singular appearance, found in most warm seas. In appearance, as in structure, this family is strictly intermediate between the sharks and the rays. Its nearest living allies are probably the *Dalatiidæ*.

32. SQUATINA Duméril.

ANGEL FISHES.

Squatina Duméril, Zool. Analyt., 1806, p. 102 (*angelus=squatina*).
Rhina Rafinesque, Caratteri Alcuni Nuovi Generi, 1810, p. 14 (*squatina*).
Rhina Klein, in Auguste Duméril, Elasmobranches, 1870, p. 464 (*squatina*).

Characters of the genus included above.

(*squatina*, the ancient name, akin to the English words "skate" and "squat.")

34. SQUATINA JAPONICA Bleeker.

TEGAIZAME (CANOPY-SHARK); KASUZAME (CHAFF SHARK); KOROZAME.

Squatina vulgaris SCHLEGEL, Fauna Japonica, Poiss., 1850, p. 305, pl. CXXXVI; Nagasaki (not of Risso).

Squatina japonica BLEEKER, Act. Soc. Sci. Indo. Neerl., 1857, III, Japan, IV, p. 40; Nagasaki.

Rhina squatina ISHIKAWA, Prel. Cat., 1897, p. 61, Tokyo (not of Linnæus).

Head 5 in length; space between spiracles $1\frac{4}{5}$ in head; interorbital space, $2\frac{1}{4}$; eye $3\frac{2}{3}$ in interorbital space.

Body broad, flattened, width of disk equal to one and five-eighths total length. Head very broad, flattened, its length a trifle more than two-thirds its width; snout very broad, short, obtuse, projecting very slightly beyond mandible; eyes small, a little closer together than spiracles, directed upward; snout well separated from mouth below by a deep furrow; jaws with about three rows of sharp, pointed teeth, upper projecting slightly beyond mandible; lips rather broad, a flap at the corner of mouth; inferior margin of head with a narrow, thin flap; nostrils closer together than eyes, on edge of snout in front; interorbital space broad, concave, this concavity extending to posterior part of head. Spiracles less than eye, and about diameter of latter distant. Gill-openings very large, septa with broad dermal laminæ crowded together before base of pectoral.

Above rough, especially along edges of dorsal and caudal; down middle of back a series of small, sharp tubercles; a number of small tubercles over eye between nostrils above; lower surface of body perfectly smooth, with exception of anterior borders of pectorals and ventrals and lower surface of tail.

Dorsals small, of about equal size, first just behind tips of ventrals, second about midway between origin of first and origin of upper caudal lobe. Pectorals with length of base about one-half of length of anterior margin, the latter not equal to breadth of head; ventrals from their origin to tip behind, shorter than anterior edge of pectoral; caudal about half head; tail broad at first, then tapering, its width in front not equal to space between outer edges of spiracles.

Color in alcohol gray-brown above, marked with very numerous, small, dark spots, so that lighter color between forms a reticulated network; toward edges of fins spots become smaller and crowded; dorsals and caudal with a few, indistinct, dark spots; lower surface of body creamy; outer edges of pectorals, deep gray-brown, blackish posteriorly, also some brown spots about bases of former, on breast, throat, a large blotch before the vent, and two streaks down tail.

This description is from specimens obtained at Kobe and Nagasaki, where it is abundant.

Coasts of Japan, common southward.

Duméril unites the Japanese species with the European *Squatina aculeata*, while Dr. Günther unites both with *Squatina squatina*. The several species of this genus, if really distinct, have yet to be defined.

Order IV. BATOIDEI.

THE RAYS.

Gill-openings inferior, slit-like, 5 in number; spiracles present; no anal fin; dorsal fins, if present, inserted on the tail; body typically disk-like, broad, and flat, the margin of the disk being formed by the expanded pectorals; tail comparatively slender, the caudal fin small or wanting. Vertebræ cyclospondylous. With the exception of the *Rajidæ*, most or all of the rays are ovoviviparous.

(*βάτος*, a ray; *εἶδος*, likeness.)

a. SARCURA. Tail comparatively thick, with 2 dorsals and a caudal fin; no serrated caudal spine.
  b. Snout not saw-like.
    c. Electric organs absent; skin not perfectly smooth.
      d. Species ovoviviparous; young developed within body of parent; disk passing gradually into long, stout tail; pectorals not extending to snout. RHINOBATIDÆ, XVII.
      dd. Species oviparous; eggs deposited in quadrangular, leathery egg cases, with a projection at each corner; disk abruptly contracted at base of tail; pectorals extending to snout........................RAJIDÆ, XVIII.
    cc. Electric organs present; a structure composed of honeycomb-like tubes between pectoral fins and head; skin perfectly smooth..NARCOBATIDÆ, XIX.
aa. MASTICURA. Tail comparatively slender; dorsal fin single or wanting; back of tail usually with a serrated spine.
    e. Pectoral fins uninterrupted, confluent around snout; teeth small. DASYATIDÆ, XX.
    ee. Pectoral fins interrupted, one portion forming detached appendages on the snout ("cephalic fins").
      f. Teeth very large, flat, tessallated, few in number..MYLIOBATIDÆ, XXI.
      ff. Teeth numerous, very small, flat or tubercular; size of body enormous; cephalic fins conspicuous, resembling horns ......MOBULIDÆ, XXII.

Family XVII. RHINOBATIDÆ.

GUITAR-FISHES.

Shark-like rays. Trunk gradually passing into the long and strong tail, which is provided with 2 well-developed dorsal fins, a caudal fin and a conspicuous dermal fold on each side; disk not very broad, the rayed portion of the pectoral fins not being continued to the snout; no conspicuous spines, the skin being nearly smooth, or with warty tubercles; no electric organs. Warm seas; distinguished from the *Rajidæ*

chiefly by the fact that the eggs are hatched within the body. The typical species are also much more elongated in form.

a. First dorsal opposite to ventrals; caudal with lower lobe well developed.
  b. Snout short and rounded, not much longer than interorbital width...*Rhina*, 33.
  bb. Snout narrow, produced and pointed, its length much greater than interorbital width..*Rhynchobatus*, 34.
aa. First dorsal much behind ventrals; anterior nasal valves not confluent; disk subtriangular or rhombic; snout more or less produced; skin covered with fine shagreen, usually with somewhat larger spines on the back of tail. *Rhinobatus*, 35.

33. RHINA Bloch and Schneider.

Rhina BLOCH and SCHNEIDER, Syst. Ichth., 1801, p. 352 (*ancyclostomus;* not of Aristotle and Klein, who, before Linnæus, used the name for *Squatina*).
Rhamphobatis GILL, Am. Lyc. Nat. Hist. N. Y., 1861, p. 408 (*ancyclostomus*).

Body depressed, the snout very broad and obtuse, its length not much greater than interorbital width, its anterior outline semicircular; back with large tubercles. Pectoral fins with the anterior margin free, not extending to the head. Gill-openings narrow, inferior, below the base of the pectoral. Spiracles wide behind the eye. No nictitating membrane. Nostrils inferior; oblique, wide slits. Teeth, obtuse, granular, the dental surfaces of the jaws undulate. First dorsal opposite ventrals; lower caudal lobe well developed.

(ῥίνη, a shark.)

35. RHINA ANCYLOSTOMA Bloch and Schneider.

Rhina ancylostomus BLOCH and SCHNEIDER, Syst. Ichth., 1801, p. 352, pl. LXXII; Coromandel.—RICHARDSON, Ichth. Chin., 1846, p. 195; Canton, and of numerous authors.
Rhamphobatis ancyclostomus GILL, Am. Lyc. Nat. Hist., N. Y., 1861, p. 408.—DUMÉRIL, Elasmobranches, 1870, p. 482 (after Bleeker).
Rhyncobatus ancyclostomus GÜNTHER, Cat. Fish, VIII, 1870, p. 440; Madras, China, Seychelles, Pinang.—DAY, Fishes of British India, I, 1889, p. 41.

Snout very broad, obtuse, with semicircular outline; large, compressed tubercles form longitudinal ridges, one on each side of upper part of head, one on median line of trunk; an incomplete series of smaller tubercles round front margin of eye and below spiracle; two short series of small tubercles on each side of trunk may be regarded as continuations of those on head; teeth 77-75, twenty two vertical rows in center of upper and twenty-seven in center of lower jaw, surface deeply undulated, with one large median and a smaller lateral elevation on the lower jaw, and with corresponding emarginations in upper; the teeth are largest on summit of each elevation, and all are obtusely rounded with several longitudinal ridges across each. Color dull brown, lighter beneath; body and sometimes fins, covered with whitish spots; occasionally some tortuous black lines. (Günther, Day.)

East Indies; a single specimen was obtained at Kinkwazan, an island off Matsushima Bay, in September, 1900, by Professor Mitsukuri.

(ἀχκυλός, undulate; στόμα, mouth.)

34. RHYNCHOBATUS Müller and Henle.

Rhynchobatus Müller and Henle, Plagiostomen, 1838, p. 111 (*lævis*.)

This genus differs from *Rhina* chiefly in the form of the snout, which is produced and pointed as usual in *Rhinobatus*. The tubercles on the back are arranged much as in *Rhina*, but are very small.

(ῥυγχός, snout; βάτος, skate.)

36. RHYNCHOBATUS DJIDDENSIS (Forskål).

TONGARI (SHARP-POINTED RAY); KOTAINOZU; SAKATAZAME; KASUKA; SUKINOSAKI (PLOW-POINT); SAKAFUTE; SUKINOSAZAKI.

Raja djiddensis Forskål, Descr. Anim., II, 1775, p. 15, figs. 1, 2; Djidda, Red Sea.

Rhynchobatus djeddensis Günther, Cat. Fish, VIII, 1870, p. 441; Red Sea, Zanzibar, Seychelles, Sumatra, India.

Rhinobatus lævis Bloch and Schneider, Syst. Ichth., 1801, p. 354, pl. LXXI; Coromandel.—Schlegel, Fauna Japonica, Poiss., 1850, p. 306, pl. CXXXIX; Nagasaki, in open sea.

Rhyncobatus lævis Duméril, Elasmobranches, 1870, p. 484; Malabar, Pondicherry.

Rhyncobatus duhameli Blainville, Fauna Française, 1828, p. 48 (after Duhamel).

Snout elongated, distance between mouth and end of snout equals one-fourth to one-fifth of entire length, excluding caudal fin, shortest in adults; eyes rather large; teeth oval, wider than broad, with a horizontal cusp across center of each, 40–42—40–42, twenty to twenty-five vertical rows across the middle of jaws, and dental plate with a central, and a smaller lateral elevation; corresponding emarginations exist in upper jaw. Spiracle close behind eye. Scales minute, of irregular shapes and sizes, keeled; a number of tubercles, directed backward, exist in rows in some parts of body; a supraorbital row extends from anterior margin of orbit round its upper edge to above spiracle; a second passes from a central point between termination of last two and proceeds along back to base of first dorsal, tubercles on it much farther apart than in other lines; from slightly behind beginning of dorsal line of spines, a short, diverging row on either side, also a row on shoulder, and two or three spines on scapula. Second dorsal begins opposite extremity of first dorsal; smaller than latter fin; its shape the same. Lateral keel begins a little above termination of ventrals. In color, immature specimens dull-gray above, whitish, sometimes tinged with red beneath; a dark or black band on the upper eyelid, and a dark spot beneath on either side of snout; also usually, but not invariably, a black spot at root of pectoral, which may have several small white ones around it; body, and sometimes pectoral fin, spotted

vith whitish, or light gray; iris golden; adult of a dull gray above ınd lighter on abdomen. (Day).

East Indies, north to Japan; seen by Jordan and Snyder at Onomichi, Hiroshima, Tsuruga, and Hakata.

A large ray, measuring 4 feet.

We have half of the head and a portion of the disk of a large exam-ɔle from Tsuruga. There is a small black spot on each side of the nout at tip; two blackish spots over the eye, and another at base of ɔectoral, with a couple of light spots near it.

(Named for Djidda in Arabia.)

35. RHINOBATUS Bloch and Schneider.

Rhinobatus Bloch and Schneider, Syst. Ichth., 1801, p. 353 (*rhinobatus*).
Leiobatus Rafinesque, Caratteri Alcuni Generi, 1810, p. 16 (*panduratus*).
Syrrhina Müller and Henle, Plagiostomen, 1838, p. 113 (*columnæ*).
Glaucostegus Bonaparte, Catologo Metodico, 1846, p. 14 (*rhinobatus*).

Body depressed, gradually passing into the tail. Cranial cartillage ɔroduced into a long rostral process, the space between the process and he pectoral fin being filled by membrane; spiracles wide, behind the ɛye; nostrils oblique, wide; anterior valves not confluent; teeth obtuse, vith an indistinct, transverse ridge. Dorsal fins without spine; both 'ar behind the ventral fins; caudal fin without lower lobe. Claspers slender and pointed. Species numerous in warm seas, varying con-siderably as to the form of the snout; those with the snout shortened ınd the nasal valves broader, constituting the subgenus *Leiobatus*, (*Syrrhina*), to which the Japanese species belong.

(*ῥίνη*, a shark; *βάτος*, a skate.)

ɩ. Leiobatus. Anterior nasal valve continued toward median line.
- *b*. Anterior nasal valve slightly continued toward median line by a short fold, far from meeting its fellow of other side; snout produced; dorsal tubercles obsolete; color uniform brown; young with brown spots............*schlegeli*, 37.
- *bb*. Anterior nasal valve continued toward median line, nearly meeting its fellow of other side; snout moderately produced; back with a median series of very small tubercles; back with dark rings..................*polyophthalmus*, 38.

37. RHINOBATUS SCHLEGEL Müller and Henle.

SAKATAZAME (SKATE-SHARK).

Rhinobatus schlegeli Müller and Henle, Plagiostomen, 1838, p. 123, pl. xlii; Nagasaki.—Schlegel, Fauna Japonica, 1850, p. 207; Nagasaki.—Richardson, Ichth., China, 1846, p. 95; Nagasaki.—Bleeker, Act. Sci. Neerl., III, 1857, Japan, p. 41.—Günther, Cat. Fish, VIII, 1870, p. 445; Japan, Formosa.—Duméril, Elasmobranches, 1870, p. 497.—Ishikawa, Prel. Cat., 1897, p. 30; Boshu.—Steindachner, Reise Aurora, 1898, p. 225; Kobe.—Jordan and Snyder, Proc. U. S. Nat. Mus., 1900, p. 337; Tokyo.

Tip of snout to spiracle $4\frac{3}{4}$ in length; width of disk $3\frac{3}{5}$ in body; space ɔetween spiracles $4\frac{1}{5}$ in space between tip of snout and spiracle; inter-

orbital space $3\frac{1}{4}$; width across body at origin of ventrals $1\frac{3}{5}$; width of mouth $3\frac{2}{3}$; space between nostrils 7 in snout; eye 7.

Body elongate and greatly depressed. Head and disk broadly expanded, width of latter about two-thirds its length; snout triangular, long, narrow, its tip narrowly rounded; eyes rather small; mouth small, below posterior margin of eye, almost straight across; teeth small, pavement-like; nostrils large, each inclined obliquely toward mouth, and space between two-thirds length of either; interorbital space flat, a supraocular ridge at each side above eye. Spiracles large, and very near posterior margin of eye. Gill-opening small.

Body very finely roughened on upper surface, more or less smooth below, with a very obsolete trace of a median keel down back of slightly enlarged denticles.

Dorsals rather large, second only a trifle smaller than first; first dorsal nearer second than origin of ventral; second dorsal nearer first than end of tail; pectorals very broad, forming greatest width of disk at its posterior third; origin of ventrals nearly midway between front of eye and origin of second dorsal. Caudal broad, depressed, its length two in snout. Sides of tail each with a strong, lateral keel below.

Color in alcohol, light brown above, below whitish; young specimens are marked with little bunches of blackish brown spots.

Length, $27\frac{1}{4}$ inches.

Described from a male specimen.

Coasts of Japan; not uncommon. This species was seen at Tokyo, Wakanoura, Onomichi, Hakata, and Nagasaki. We have specimens from Hiroshima, Hakata, Nagasaki, and Wakanoura; also one from Tokyo, taken by K. Otaki. In this latter specimen, the lower surface of the snout is dark brown.

(Named for Professor Schlegel.)

38. RHINOBATUS POLYOPHTHALMUS Bleeker.

Rhinobatus polyophthalmus BLEEKER, Nieuwe Nalezing, 1854, Japan, p. 129; Nagasaki; Nat. Tyd. Ned., Ind., VI, 1854, p. 423; Act. Soc. Sci. Indo. Neerl., III, 1857, Japan, IV, pl. IV.

Rhinobatus columnæ STEINDACHNER, Reise Aurora, 1898, p. 225; Kobe (not of Bonaparte).

Head $4\frac{1}{4}$ in length; snout $6\frac{1}{3}$ in head; eye 5 in snout; width of disk $2\frac{3}{4}$ in its length. Snout acute, processes of rostrum not distinct; nares more than their length, distant, continued below till narrowly separate; nasal flap fringed; lips without sulcation above, continuous below; mouth scarcely undulated, remote from margin of disk. Spiracle close to eye. Orbital ridge armed in front with some spines; lower surface of rostrum smooth; scales very small; 40 small spines down center of back in front of first dorsal. Dorsals subequal, scarcely emarginate, much higher than length of their bases, and

about double their length distant; pectoral broadly rounded; ventrals subrhomboid anteriorly, and obtusely rounded, acute behind; above, yellowish-green, with oblong and rounded rings of olive-violet, frequently interrupted with numerous spots; below, whitish.

Nagasaki. (Bleeker.)

Length, 312 mm.

Coasts of Japan. This species was seen by the senior author at Wakanoura, Hiroshima, Hakata, and Nagasaki. It may be identical, as Duméril indicates, with *R. annulatus* Smith, from the Cape of Good Hope, but this should not be admitted without comparison of specimens. According to Steindachner, it is the young of the East Indian *Rhinobatus columnæ* Bonaparte.

(πολύς, many; ὀφθαλμός, eye.)

Family XVIII. RAJIDÆ.

SKATES.

Disk broad, rhombic, the skin more or less roughened with spines or prickles; tail stout, rather long, with a longitudinal fold on each side; usually 2 dorsal fins and sometimes a caudal fin present, all on the tail; pectoral fins extending to the snout; ventrals large; no serrated spine on the tail; no electric organs. Oviparous, the eggs being laid in large, leathery egg cases, 4-angled, with 2 long, tubular "horns" at each end. Found in all cool seas, some of the species in deep water.

a. Caudal fin well developed; ventral fins separate; pectoral fins confluent around snout .... *Discobatus*, 36.

aa. Caudal fin rudimentary or absent; pectorals not confluent around the snout; ventrals deeply notched .... *Raja*, 37.

36. DISCOBATUS Garman.

Platyrhina Müller and Henle, Plagiostomen, 1838, p. 125 (*sinensis*, name preoccupied).

Discobatus Garman, Proc. U. S. Nat. Mus., 1880, p. 522 (*sinensis*).

Disk rhombic, the snout rounded in front; tail very distinct, with a fold on either side, and with two dorsals and a well-developed caudal. Body rough, with spines above. Pectoral fins united in front, forming fore part of snout. Ventral fins separate.

39. DISCOBATUS SINENSIS (Bloch and Schneider).

UCHIWAZAME (FAN-FISH).

Raie chinoise Lacépède, Hist. Nat. Poiss., I, pp. 34, 157, pl. II, fig. 2 (from a Chinese painting).

Rhina sinensis Bloch and Schneider, Syst. Ichth., 1801, p. 352 (after Lacépède).

Platyrhina sinensis Müller and Henle, Plagiostomen, 1838, p. 125, pl. XLIII; Nagasaki (on a figure of Burger).—Schlegel, Fauna Japonica, 1850, p. 307 (no description).—Duméril, Elasmobranches, 1870, p. 576; Cochin China.—Günther, Cat. Fish., VIII, 1870, p. 471; China,

Snout 7¾ in head; space between spiracles 1¾ in snout; space between nostrils 4½ in snout; eye 7 in snout.

Disk very broad, much broader than long. Head greatly flattened; snout confluent with pectorals; eyes small; mouth nearly straight, and not quite as wide as space between outer margins of eyes; teeth numerous, small, and flattened, or molar-like; nostrils large, oblique toward mouth, and either equal to space between; interorbital space flattened, even a trifle concave, and a supraoral ridge on each side, somewhat broad; spiracles directly behind eye, and rather round and deep. Gill-openings small.

Upper surface of body very rough with small prickles; a median series of small bucklers from behind the head to first dorsal, and between the latter and second dorsal; several small bucklers over eye in front, and over the spiracles; several bucklers on each side of the body near the base of pectoral; lower surface of the body very finely roughened.

Dorsals small and posterior on tail, alike in shape, and posterior a little larger; origin of first dorsal nearer that of ventrals than tip of caudal; second dorsal a short distance from first, its origin a little nearer tip of ventral than tip of caudal; pectorals very broad, and with snout form a very blunt angle in front; space between ventrals below greater than snout; caudal equal to snout and eye. Sides of tail below, with a fold on each side, running from ventrals to caudal. Caudal peduncle very short.

Color in alcohol muddy brown above, white below; bucklers over eyes, and spiracles, together with those on sides, and the first four of the median row, cream white.

Length 20⅝ inches.

This description from an example taken at Hiroshima.

Coasts of Japan and China; not rare. We have specimens obtained at Wakanoura and Hiroshima.

(*sinensis*, Chinese.)

37. RAJA Linnæus.

Raja LINNÆUS, Syst. Nat., 10th ed., 1758, p. 231 (*batis*).

Dipturus RAFINESQUE, Caratteri Alcuni Generi, 1810, p. 16 (*batis*).

Platopterus RAFINESQUE, Analyse de la Nature, 1815, p. 93 (*batis*).

Dasybatus BLAINVILLE, Journ. Phys., 1816, p. 260 (*communis*).

Propterygia OTTO, Nova Acta Acad. Caes. Leop. Carol. Nat. Curios, 1824, p. 111 (*hyposticta;* monstrous example, with fins not adnate to head).

Læviraja BONAPARTE, Fauna Italica, XXV, 1839, p. 130 (*oxyrhynchus*).

Uraptera MÜLLER and HENLE, Plagiostomen, 1838, p. 155 (*agassizi;* species without caudal fin).

Batis BONAPARTE, Cat. Metod., 1846, p. 12 (*radula;* no description).

Malacorhinus GARMAN, Bull. Mus. Comp. Zool., XI, 1881, p. 236 (*plutonia;* species with imperfect rostral cartilage; probably recognizable as a valid genus when the species are better known).

Raia various authors, change of spelling.

This genus, as here understood, comprises all those *Rajidæ* which ıave the pectoral fins not continued around the snout, the ventrals leeply notched, and the caudal fin little developed, or wanting. The ail is very distinct from the disk, and is provided with 2-rayed dorsal ins. The skin of the body is usually more or less spinous; the dentiion differs in the two sexes, and the male is usually provided with a lifferentiated patch of spines on each pectoral. Species numerous, nostly of the northern seas.

(*raja* or *raia*, a ray, or skate.)

:. Snout not produced.

b. Dorsal fins united; a single row of spines on back of tail; everywhere roughened above; no spines on supraorbital ridge.......................*isotrachys*, 40.

bb. Dorsal fins well separated; skin above mouth smooth.

c. Angle of disk posterior to middle of its length; several rows of spines on back of tail (only 1 row in young); spines on supraorbital ridge.

d. Teeth in 30 rows; size large......................................*fusca*, 41.

dd. Teeth in 45 rows; size moderate.........................*meerdervoorti*, 42.

bb. Angle of disk about opposite center of its length, and its anterior margin broadly convex; 5 irregular rows of spines on back of tail; teeth in 45 rows. *kenojei*, 43.

ıa. Snout very long, produced, tapering to a narrow point; teeth in 38 rows. *tengu*, 44.

40. RAJA ISOTRACHYS Günther.

Raja isotrachys GÜNTHER, Deep Sea Fishes, Challenger, 1887, p. 7, pl. III; south of Japan.

Snout rather produced, anterior margins meeting at nearly a right ıngle; distance between outer margins of nostrils equals their distance from end of snout; teeth small, each with a point directed backward toward interior of buccal cavity. Body and tail entirely covered on upper surface with minute asperities, each with a stellate base; no spines on superciliary margin; a single small spine in middle of back; a series of rather strong spines (eighteen) along the median line of tail, none on sides. Outer pectoral angle rounded, margins of fin would meet at a right angle. Upper parts uniform, brownish-gray; lower parts smooth, brownish-black. A female taken at Station 235 in 365 fathoms. (Günther.)

This species we only know from Günther's description. The plate represents the dorsals as joined at base.

South of Japan, in deep water; one female known, 22½ inches long.

(ἴσος, equally; τραχύς, rough.)

41. RAJA FUSCA Garman.

Raja fusca GARMAN, Proc. U. S. Nat. Mus., 1885, p. 42; Japan.

(Type, No. 26542, Mus. Comp. Zool.; taken from the egg case.)

A very young specimen of some large skate, resembling *Raja meerdervoorti*, taken from the egg case, is thus described by Mr. Garman:

Length, 4⅜ inches; width, 2; length of pectorals, 1½ inches.

Disk three-fourths as long as wide. Snout moderately prominent. General outline similar to that of *Raja ocellata*. Tail from vent equals the length of the disk including the ventrals; depressed, rather broad at the dorsals, behind which it extends in a long point that probably is much reduced in comparative length in the adult. Teeth in 30 series. Eyes moderate; interorbital space nearly half their distance from the end of the snout. Mouth broad, with a slight forward curve. A pair of large spines in front of each eye; a single spine above each spiracle; one behind the head on the anterior end of the vertebral column, sometimes a second behind this on the shoulder girdle, and a median row on the tail, beginning behind the vent and reaching the second dorsal. Dorsals separated by two spines. Excepting these spines, the back is smooth.

Light reddish brown; a black ring, half as wide as the mouth, incloses a light colored space near the shoulder girdle on each pectoral.

The large size of this fetus renders it probable that it belongs to a species distinct from *Raja meerdervoorti* and perhaps allied to *Raja ocellata*.

(*fuscus*, dusky.)

42. RAJA MEERDERVOORTI Bleeker.

Raja meerdervoortii[a] BLEEKER, Act. Sci. Ind. Neerl., VIII, 1860, p. 66; Japan.—JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1900, p. 337; Tokyo.

Snout $7\frac{3}{5}$ in head: interorbital space $1\frac{3}{5}$ in snout: width of mouth $1\frac{2}{5}$: length of first dorsal, $1\frac{5}{6}$; eye $3\frac{1}{2}$ in interorbital space.

Body broad, disk much wider than long, its anterior margin undulated. Head small; snout slightly produced, pointed; eyes small, interorbital space greater than distance of eye from margin of disk; mouth rather small, undulated, about as far from tip of snout as latter is from eye; nostrils large, their distance from corners of mouth two and two-thirds in space between latter and tip of snout; internasal space one and one-fifth width of mouth; teeth rather small, sharply pointed, in about 45 rows in upper jaw; upper lip free in middle; nostrils very large, broadly separated at corners of mouth, with which they are confluent, and with a large flap, posterior margin of which is broadly fringed; interorbital space broad, concave, supraoral ridges not particularly elevated. Spiracles much smaller than the eye and directly posterior. Gill-slits small.

Above, roughened on snout in front, along anterior undulated margins of disk; a patch of thorns on each side of pectorals, on their outer third; several spines or tubercles on each supraorbital ridge; several in front of eye; a couple on middle of back in front, and three rows

[a] Disk rhomboid, its anterior borders undulate, a little broader than long; snout very sharp, greater than internasal space, length from mouth half more than width of latter; median teeth in male, pointed. Back smooth, with a single, conical, curved spine on its median region; several spines before, and within the eyes; the outer spines on the anterior region in 3 to 5 series. Tail a little shorter than the disk; claspers (in the type 21 cm. long) very large. Olive-green above, orange along the edge of disk; pale ocelli of varying size more or less evident; pores on the lower side of head bordered with black. (Bleeker).

upper surface of tail; also a supero-lateral row of small spines; with these exceptions, smooth; lower surface of body perfectly smooth, except end of snout.

First dorsal larger than second, from which it is well separated, intervening space equal to one-fifth length of base of first; second

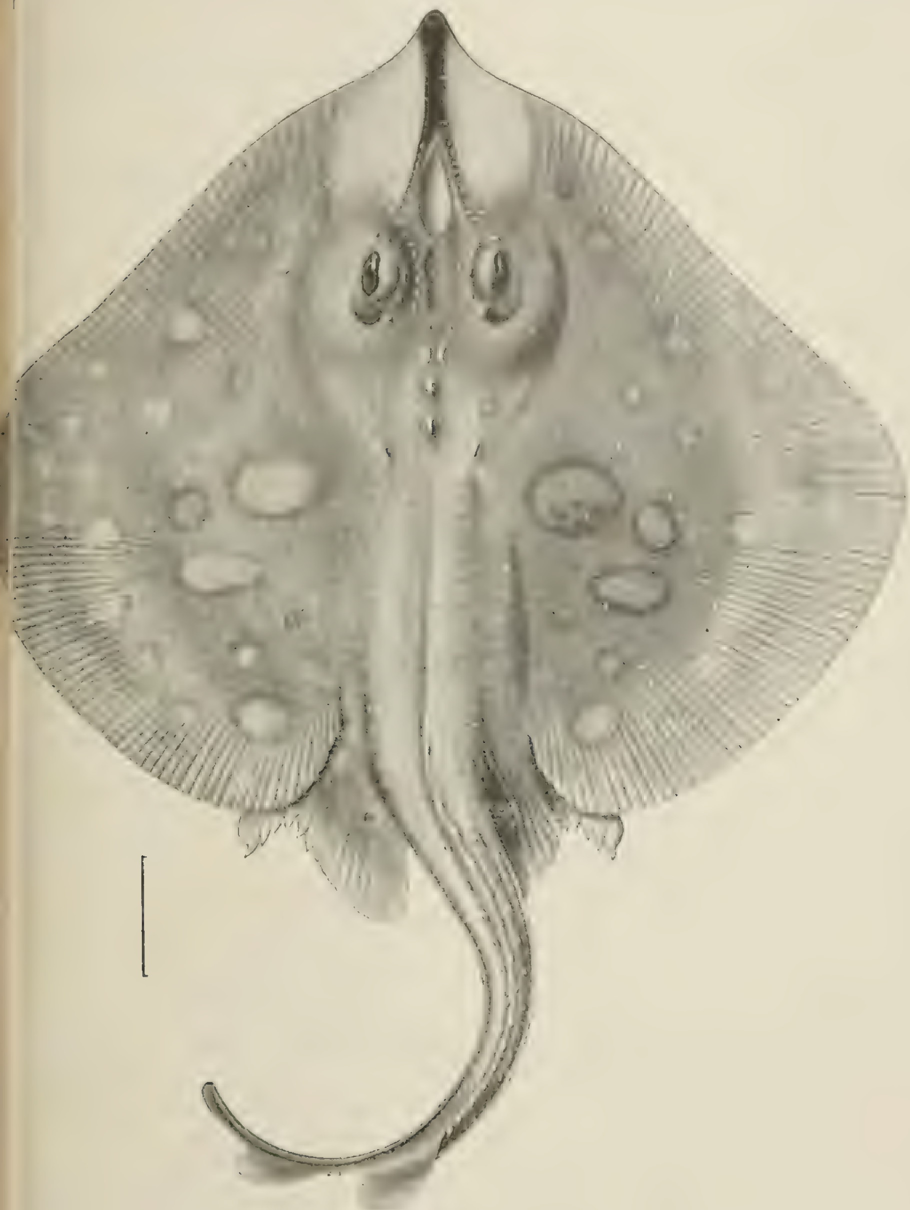


Fig. 7.—Raja meerdervoorti.

dorsal and caudal joined, only separation a deep notch; angle of pectoral obtuse; ventrals four-fifths length of claspers; claspers more than half of tail, when measured above from posterior base of ventrals; a narrow lateral fold along each side of tail.

Color in alcohol, brown above, clouded with darker, and with many

light blotches on pectorals; at middle of base of pectorals, two large, round, light spots; behind these, also farther apart, two round blackish spots; edges of disk, ventrals, and tail light brown; lower surface of body whitish, more or less soiled with dusky, and pores with blackish dots.

Length 14¾ inches.

Described from a young male from Nagasaki.

A large male from Kobe differs in having the colors more or less uniform, the spots obsolete. Its lower surface is greatly soiled with pale brown.

Our adult females, all larger than any of the males, differ principally in their greater width. They also have the eyes closer together, the space between always less than their distance from the margin of the disk. They are more or less uniform in color like our adult male from Kobe. One from Tokyo is very dark, or soiled, below. The mouth is nearly straight.

In a smaller specimen than any yet mentioned the spots and marblings above become more distinct, especially the two large spots at the base of the pectorals. However, there are still three rows of tubercles on the upper surface of the tail.

In our still smaller and youngest specimens there is great variation. In most of the males the distance between eyes is less than distance from the margin of the disk. The lower black spots on the pectoral above disappear, and the light spots at the base of the same fin vary from narrow-rimmed ocelli to deep blackish blotches. The tail is seldom with more than a single median row of tubercles above.

Coasts of Japan, very abundant. Our specimens from Tokyo, Nagasaki, Kobe, Wakanoura, and Hakodate. It is possible that more than one species is included in our series.

(Named for J. L. C. Pompe van Meerdervoort, who collected for Dr. Bleeker.)

43. RAJA KENOJEI Müller and Henle.

GANGI-EI (SEA-WALL RAY); KENOEI, KASUBE, SEBITA (FLAT-BACK); IGA-EI (SPINY RAY); RENTE-EI.

Raja kenojei Müller and Henle, Plagiostomen, 1838, p. 149, pl. XLVIII; Nagasaki.—Schlegel, Fauna Japonica, 1850, p. 308; Nagasaki.—Richardson, Ichth. Chin., 1846, p. 197; Canton.—Bleeker, Act. Soc. Sci. Ind. Neerl., III, 1858, Japan, IV, p. 42; Japan, VI, 1859, p. 65.—Duméril, Elasmobranches, 1870, p. 557; Nagasaki.—Günther, Cat. Fish, VIII, 1870, p. 463; Japan.—Nystrom, Kongl. Svensk. Vet. Ak., 1887, p. 51; Nagasaki.—Ishikawa, Prel. Cat., 1897, p. 60; Tokyo.—Jordan and Snyder, Proc. U. S. Nat. Mus., 1900, p. 337.

Raja japonica[a] Nystrom, Kongl., Svensk. Vet. Ak., 1887, p. 52; Nagasaki.

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[a] *Raja japonica* is characterized thus by Nystrom:

"Distance from middle of forehead between eyes to tip of snout less than half breadth of head at same point; distance between outer angles of nostrils somewhat

Interorbital space $1\frac{1}{2}$ in snout; width of mouth $1\frac{2}{5}$; length of first dorsal, a little more than $\frac{1}{2}$; caudal $2\frac{3}{4}$; eye $3\frac{1}{2}$ in interorbital space.

Body rhomboid, very broad, width of the disk much greater than its length. Head small; snout very little produced, though ending in a small point; anterior margin of disk full, slightly undulated, and eyes nearer to it than their space between; mouth large, slightly undulate; teeth in about 45 rows in upper jaw, small, rounded; nostrils very large, broadly separated, but not equal to width of mouth at its corners, with which it is also confluent; nasal flaps large, posterior margin fringed; length of nostril to corner of mouth equal to two and one-half in space between latter and tip of snout; interorbital space concave, though flattened in middle, and supraorbital ridges little elevated. Spiracles rather large, a little smaller than eye, oblique, directly posterior. Gill openings very small.

Body almost perfectly smooth, with exception of some roughness on snout, several small tubercles on supraoral ridges, one in center of back in front, and 5 irregular rows of thorns on back of tail.

Dorsals separated, distance between about one-sixth base of first; second dorsal confluent with small caudal, only separation a deep notch, and equal to first dorsal in size; angle of pectoral would fall at about middle of length of disk; ventrals moderate.

Color in spirits, brown above, whitish beneath; upper surface marked with small, blackish spots; at bases of pectorals, two large, blackish rings above, below which, though farther apart, also two indistinct, imperfect rings, and still posterior on last rays, a small, black spot; nine indistinct, blackish cross-bands on upper surface of tail; lower surface of body whitish, soiled with brown, pores with grayish borders.

Length $17\frac{1}{2}$ inches.

Coasts of Japan, rather common. We have specimens from Misaki, Tokyo, Wakanoura, Kobe, Tsuruga, and Nagasaki. As this species is mature at about the length of the specimen described, the rays "de taille enorme" noticed by Schlegel must belong to *Raja tengu* or some other species. In our young specimens the spots on the back form more or less distinct ocelli, and the mottlings above are distinct, frequently with a number of light spots. The lower surface is white, but the outer third of the pectorals broadly bordered with pale brown, which in the adult is paler.

(*Keno-ei*, the Japanese name.)

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less than their distance from tip of snout; snout somewhat rounded; mouth with 40 rows of teeth; interorbital space concave. A few small tubercles about eyes; rest of body smooth, except for a large tubercle behind eye and a row of larger or smaller ones along middle of back. Color dark brown, with larger and smaller yellowish spots. Described from a specimen $2\frac{1}{2}$ cm. long, taken at Nagasaki."

44. RAJA TENGU Jordan and Fowler, new species.

TENGU-EI (LONG-NOSED RAY).

Interorbital space 3 in snout; width of mouth $2\frac{2}{3}$; length of fi dorsal $4\frac{1}{4}$; caudal 6; eye $4\frac{1}{2}$ in interorbital space.

Body very broad, width of disk much greater than its length. He large; snout greatly produced, tapering to a sharp point; eyes sma rather far apart, though farther from margin of disk than this interv; mouth large, slightly curved or arched, with 38 rows of large teeth jaws; upper lip not free in middle; nostrils very large, broadly sep rated at corners of mouth, with which they are confluent, and witl

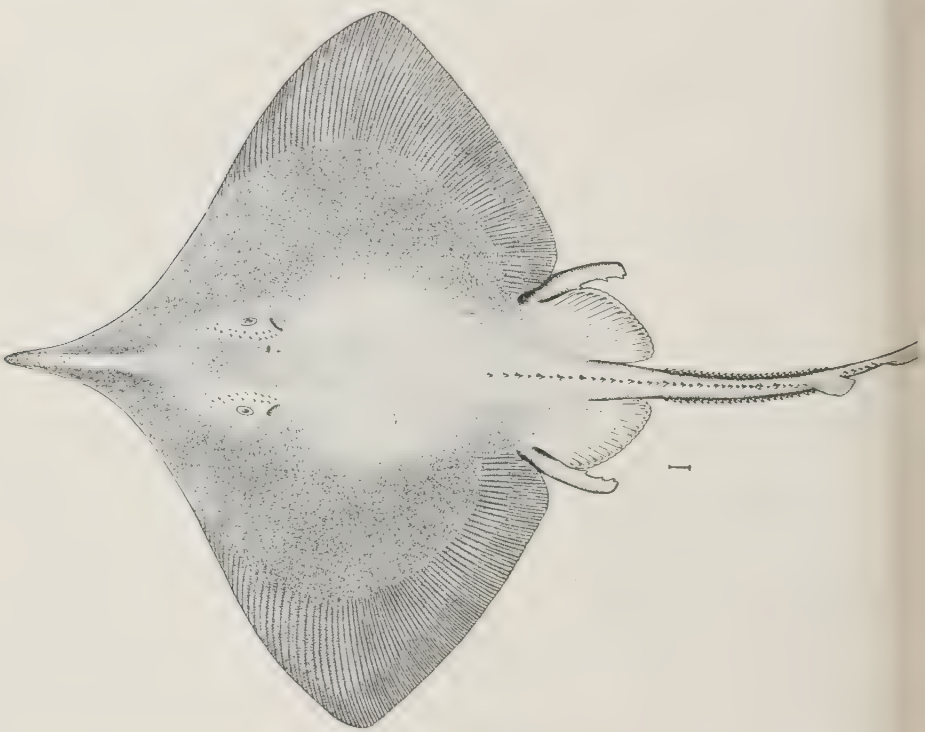

FIG. 8.—RAJA TENGU.

large flap, the posterior margin of which is broadly fringed; spa between anterior part of nostril and corners of mouth 5, in spa between former and tip of snout; interorbital space broad, concav the supraoral ridges large, broad and convex. Spiracles smaller tha eye, oblique, directly posterior. Gill-slits small.

Snout roughened above; a number of small spines in front of a over eye, several on back behind head; a single row of spines dow middle of tail above, a row on each side of same, and all rest of upp surface perfectly smooth; lower surface of body, except ventrals an tail, roughened, especially on snout.

First dorsal a little larger than second, from which it is well sep rated, intervening space equal to two-thirds length of second dorsa

second dorsal and caudal separated by a notch; angle of pectoral obtuse; ventrals small.

Color in spirits brown, more or less finely mottled with lighter, and lower surface like upper; pores below blackish.

Length 44 inches.

Type No. 7138, Ichthyological collections, Leland Stanford Junior University Museum. Locality, Matsushima Bay.

Cotypes are in U. S. National Museum, from station No. 3770, Matsushima, where they were dredged by the U. S. Fish Commission steamer *Albatross*.

The type is a young female, but is easily distinguished from other species by the elongate snout, which is, however, not so long as that of the adult; distance between eyes less than their distance from the margin of the disk; a pair of stout spines in front of each eye, a single one behind each, and a single one on the middle of the back, in front; middle of the tail with a single row above, and all the rest of the body, both above and below, smooth. Color more or less deeper brown above, marbled with darker; below, brownish; the pores on the under surface of the head, bordered with blackish. Length $8\frac{1}{2}$ inches.

Coasts of Japan, especially northward; rather common. It was obtained at Aomori, Hakodate, and Matsushima.

(Named from *Tengu* or *Tegu*, in Japanese mythology, a comical being with a very long nose, which he is fabled to thrust into the business of other people.)

Family XIX. NARCOBATIDÆ.

ELECTRIC RAYS.

Trunk broad and thick, covered with perfectly smooth skin. Tail comparatively short and thick, with rayed caudal fin, and commonly 2 rayed dorsal fins, the first of which is over or behind the ventrals; a longitudinal fold on each side of the tail; anterior or nasal valves confluent into a quadrangular lobe; a large electric organ, composed of many hexagonal tubes between the pectoral fins and the head. Rays of moderate or large size, noted for their power of giving electric shocks; found in most warm seas. According to Fritsch the torpedoes pass through three distinct phases of development—a shark-like, a ray-like, and finally a torpedo-like stage. The very young have long, external gills.

a. Dorsal fin single; spiracles close behind eye; tail with a fold on each side. *Astrape*, 38.

38. ASTRAPE Müller and Henle.

Astrape Müller and Henle, Plagiostomen, 1838, p. 130 (*capensis*).

Dorsal fin single. Disk rounded, not emarginate in front; snout short, not keeled; spiracles with entire edges, near the eyes; mouth narrow, protractile, surrounded by a circular fold of skin, joined to the

nasal valve by a cartilaginous frenum; teeth flattened, quadrangular at base, not occupying the whole cleft of mouth. Skin smooth.

(ἀστραπή, lightning.)

45. ASTRAPE JAPONICA Schlegel.

SHIBIREI (SHOCKED RAY).

Astrape japonica[a] SCHLEGEL, Fauna Japonica, 1850; p. 307, pl. CXL; Nagasaki.
Astrape dipterygia ISHIKAWA, Prel. Cat., 1897, p. 60; Tokyo, Sagami Bay, Ajiro in Izu (probably not of Schneider).

Disk round and equal to tail, which is broad, compressed, and tapering. Head very small; snout short, equal to space between spiracles; eyes very small; 4 in space between spiracles; nostrils large, rather close together, median flap only separated slightly by a thick frenum; mouth not very broad, about one-half width between spiracles, and jaws with flattened pavement-like teeth; interorbital space nearly flat. Spiracles larger than eye, and with their edges elevated.

Body perfectly smooth, but with many pores, especially along outer portions of pectorals.

First dorsal, when depressed, reaching base of caudal, and equal to half its length; length of base of ventral is equal to width of caudal at base; tail greatly depressed, broad, and along sides, a rather narrow, lateral fold.

Color in alcohol, brown above; caudal, dorsal, and middle of tail, deep brown; lower surface with greater portion soiled with pale brown, remaining portions whitish.

Length, 7 inches.

This description from a male from Wakanoura.

Coasts of Southern Japan, not common. Our single example is from Wakanoura.

Family XX. DASYATIDÆ.

STING RAYS.

Disk usually more or less broad than long; the pectoral fins uninterruptedly confluent in front, forming the tip of the snout; tail variously formed, usually whiplike, sometimes short and stout, sometimes bearing a single dorsal or caudal fin, but never with two dorsals; usually one or more vertical folds of skin on tail, rarely a lateral fold. Tail generally armed with a large, sharp, retrorsely serrate spine on its upper surface toward the base; 2 or 3 spines occasionally present. Ventral fins not emarginate. Skin smooth, or variously prickly or spinous, roughest in the adult; no differentiated spines on the pectorals in the males, the sexes being similar. Mouth rather small; teeth

[a] *Narcine timlei*, a related species, is ascribed to Japan by Günther, following Richardson. There is no evidence that it has ever been taken in Japan. Perhaps *Astrape* has been mistaken for it.

small, paved, usually more or less pointed or tubercular. Nostrils close together; nasal valves forming a r ctangular flap, which is joined to the upper jaw by a narrow frenum. Spiracles large, placed close behind the eyes. Skull not elevated, the eyes and spiracles superior. Species ovoviviparous. Found in most warm seas, some of them in the fresh waters of the northern parts of South America. The large, jagged spine on the muscular tail is capable of inflicting a severe and even dangerous wound.

a. UROLOPHINÆ. Tail stout, provided with a rayed caudal fin; no dorsal fin; disk roundish; caudal spine strong................................ *Urolophus*, 39.

aa. DASYATINÆ. Tail slender, without caudal fin; pelvis without sword-shaped process. (Marine species.)

b. Tail whiplike, longer than disk, which is rhomboid, or roundish; caudal spine strong................................ *Dasyatis*, 40.

bb. Tail very short, shorter than the very broad, transversely rhombic disk; caudal spine weak, often wanting; no trace of dorsal fin............ *Pteroplatea*, 41.

39. UROLOPHUS Müller and Henle.

Leiobatus[a] BLAINVILLE, Jour. Phys., LXXXIII, 1816, p. 262 (*cruciatus;* not *Leiobatus*, Rafinesque, 1810).

Leiobatis BLAINVILLE, Faune Française, 1828, p. 43 (no type named).

Urolophus MÜLLER and HENLE, Plagiostomen, 1838, p. 173 (*aurantiacus=cruciatus*).

Urotrygon GILL, Proc. Ac. Nat. Sci. Phila., 1863, p. 173 (*mundus*).

Disk oval or rhombic, the length and breadth not very unequal; snout rounded or the tip exserted; skin smooth or more or less prickly. Tail rather short, little if any longer than the disk, muscular, provided with a distinct rayed caudal fin; no dorsal fin. Upper part of the tail with a strong, serrated spine. Warm seas. Sting rays of small size, the most vigorous and most dangerous of the group, mostly confined to tropical America.

(οὐρά, tail; λόφος, crest.)

46. UROLOPHUS FUSCUS Garman.

JUNORUI.

Urolophus fuscus GARMAN, Proc. U. S. Nat. Mus., 1885, p. 41; East Coast of Japan (Type No. 7058, U. S. Nat. Mus.).

Urolophus tullbergi NYSTROM, Kongl. Svensk. Vet. Akad., 1887, p. 53; Nagasaki (Coll. Dr. W. Tullberg).—JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1900, p. 338; Tokyo.

Disk round, angles of pectorals about opposite first two-fifths its length. Head small, snout produced only in a short point; anterior edge of disk broadly convex; eyes rather small, 5 in snout and $3\frac{1}{3}$ in interorbital space; nostrils large, confluent with mouth only separated in middle by a thick frenum; mouth small, $1\frac{1}{2}$ in interorbital space;

[a] In the Faune Française, 1828, Blainville changes "*batus*" in this and all similar names to "*batis*," thus *Leiobatis*, *Aëtobatis*. In this form the name *Leiobatis* has priority over *Urolophus*, but being not a new name, but a mere variant in spelling, it is perhaps not necessary to adopt it as the name of this genus.

jaws with flattened, pavement-like teeth; interorbital space concave supraocular ridges little elevated. Spiracles large, much greater than than eye.

Body perfectly smooth, with many pores.

Base of ventral about equal to snout; caudal rather broad, rounded lower lobe beginning before upper, and width of fin $2\frac{3}{4}$ in snout; tail depressed, its width at base 2 in snout, armed with a strong, compressed spine with serrate edges.

Color in alcohol, light brown above, pores with blackish borders caudal fin, a blotch below each eye and upper surface of tail blackish lower surface whitish, except lower surface of tail, which is blackish edges of ventrals and of disk broadly edged with blackish or brownish.

Length, $14\frac{3}{4}$ inches.

This description from a female from Tokyo.

Southern Japan, generally common. Our specimens are from Tokyo Kobe, Hiroshima, Hakata, and Wakanoura.

(*fuscus*, brown, dusky.)

40. DASYATIS Rafinesque.

STING RAYS.

Dasybatus KLEIN, missus, 1742 (pre-Linnæan).

Dasyatis RAFINESQUE, Caratteri di Alcuni Nuovi Generi, 1810, p. 16 (*ujus* = *pastinaca*).

Uroxis RAFINESQUE, Indice d'Ittiol. Sicil., 1810, p. 61 (*ujus*).

Trigonobatus BLAINVILLE, Jour. Phys., 1816, p. 261 (*vulgaris*).

Trygon ADANSON, in Cuvier, Règne Animal, 1st ed., 1817, p. 136 (*pastinaca*).

Hemitrygon MÜLLER and HENLE, Mag. Nat. Hist., 1837, p. 90 (*bennetti*).

Himantura MÜLLER and HENLE, Wiegmann's Archiv., 1837, p. 400 (*uarnak*).

Pastinaca SWAINSON, Classn. Anim., 1839, p. 319 (*olivacea*).

Anacanthus EHRENBERG, in Swainson, Classn. Anim., 1839, p. 319 (*orbicularis*).

Pastinaca DE KAY, N. Y. Fauna, Fishes, 1842, p. 373 (*pastinaca*).

Dasibatis GARMAN, in Jordan and Gilbert, Synopsis, 1883, p. 65 (*pastinaca*; corrected orthography).

Disk oval, flat, with rounded angles. Tail very long and slender, whip-like, without fin, but often with 1 or 2 vertical, membranous folds; a strong serrated spine toward the base of the tail. Skin more or less spinous or prickly, rarely smooth. Teeth small, paved; a few papillæ usually present in the mouth behind the lower jaw. Species about 30. Sting rays of large size, abundant in warm seas. Many of the spinous species are nearly or quite smooth when young, becoming rough with age. Some of the species are yet imperfectly known and much of the synonymy is uncertain.

(δασύς, shaggy or rough; βάτις, a skate; abbreviated from *Dasybatis*.)

a. DASYATIS: Tail with cutaneous folds.

b. Snout not long and produced.

c. Two appendages at bottom of mouth inside; tail ½ larger than disk; under side dusky gray, without red in life...*kuhlii*, 47.

cc. Three appendages at bottom of mouth inside; under side, pale orange red in life...*akajei*, 48.

bb. Snout long and produced, so that greatest width of disk would be about opposite to middle of its length...*zugei*, 49.

aa. Himantura: Tail without cutaneous folds; three times length of disk. *gerrardi*, 50.

47. DASYATIS KUHLII (Müller and Henle).

Trygon kuhli Müller and Henle, Plagiostomen, 1838, p. 164, pl. ci; Vanicoro, New Guinea (drawing from a specimen from Nagasaki).—Schlegel, Fauna Japonica, 1850, p. 308; Nagasaki.—Bleeker, Verh. Bat. Gen. Plag., XXIV, 1852, p. 73.—Duméril, Elasmobranches, 1870, p. 603; Amboina, Java, Vanicoro, New Guinea.—Günther, Cat. Fish, VIII, 1870, p. 479; Zanzibar.

The margins of snout form an obtuse angle; only two appendages at bottom of mouth, behind teeth. Body entirely smooth, or with a series of spines, pointing backward along the median line of back to caudal spine. Tail with a distinct cutaneous fold above and below, about one-half larger than disk.

Coasts of Japan and southward, not common, readily known from *D. akajei* by the grayish, not reddish, coloration of the lower side. Our specimens from Hakodate, Tokyo, Misaki, Wakanoura, Onomichi, and Hiroshima.

(Named for the naturalist, M. Kuhl.)

48. DASYATIS AKAJEI (Müller and Henle).

AKA-EI (RED SKATE).

Trygon akajei Müller and Henle, Plagiostomen, 1838, p. 165, pl. liii, Nagasaki.—Schlegel, Fauna Japonica, 1850, p. 308; Nagasaki.—Bleeker, Act. Soc. Sci. Indo.-Neerl., III, 1857, Japan, IV, p. 44.—Duméril, Elasmobranches, 1870, p. 604; Nagasaki.

Disk broadly oval; widest part about second fifth of its length. Head moderate, snout produced into a short, though very blunt point, and anterior edge of disk very broadly convex; eyes small, elevated a little, and 5 in interorbital space; nostrils large, confluent except for the thick, cartilaginous frenum; mouth small, more than one-half snout; teeth flattened, pavement-like; lower lip with narrow folds; interorbital space broad, flat. Spiracles not quite twice eye.

Body smooth, except a patch of asperities between and posterior to each eye, and a median series on back, developing posteriorly, into large thorny spines to caudal spine; end of tail rough; rest of body perfectly smooth.

Base of ventral less than interorbital space; tail much larger than disk, tapering rapidly till very slender, its width at base more than half interorbital space; spine on upper part of tail inserted a little before first third of its length, longer than snout, and serrate on both

edges on outer half; a small keel on tail above, behind spine, and a long one runs along lower surface.

Color in alcohol dark, dusky brown above, becoming lighter on outer and marginal portions of disk; lower surface of body a creamy white; a creamy buff bar in front of and below eye, also another about spiracles, above and at corners; sides of tail whitish, also edges of claspers. The belly is more or less bright orange red in life.

Length, 27⅝ inches.

Here described from an adult male from Tokyo.

Young specimens are perfectly smooth above, without any asperities or thorns, the colors more pronounced, the outer half of the tail black, and the lower surface of the body more or less tinged with creamy or light buff.

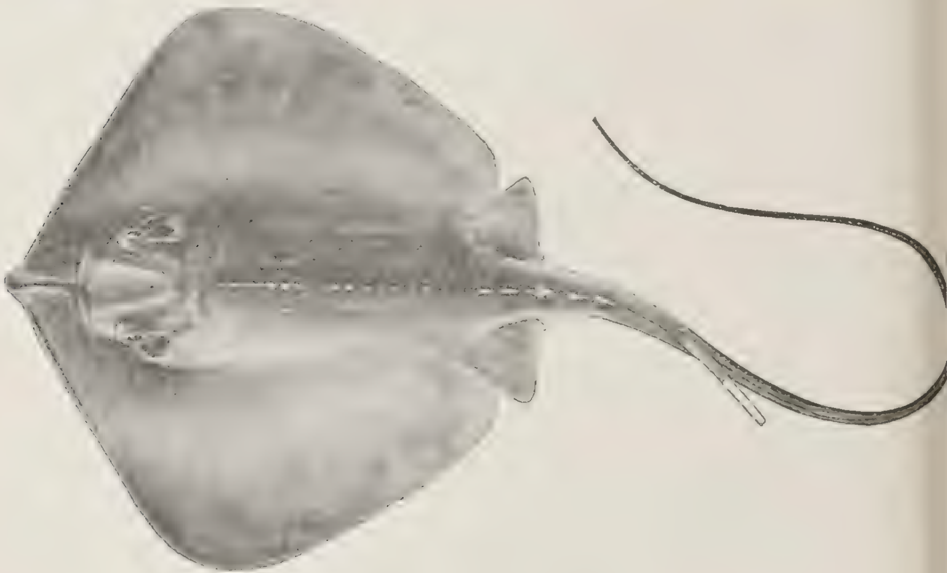

Fig. 9.—Dasyatis akajei.

Coasts of Japan, very common southward in sandy bays. Our specimens from Matsushima, Tokyo, Misaki, Wakanoura, Onomichi, Hiroshima, Tsuruga, Hakata, Kawatana, and Nagasaki.

(*aka-ei*, red skate, in Japanese.)

49. DASYATIS ZUGEI (Muller and Henle).

ZUG-EI.

Trygon zugei Müller and Henle, Plagiostomen, 1838, p. 165, pl. liii; Nagasaki.—Schlegel, Fauna Japonica, 1850, p. 309; Nagasaki.—Cantor, Malayan Fishes, 1850, p. 426.—Bleeker, Verh. Bat. Gen., XXIV, 1852, Plagiost., p. 68; Macao, Pondicherry.—Duméril, Elasmobranches, 1870, p. 606.—Günther, Cat. Fish, VIII, 1870, p. 481; Japan, Pinang, Madras.

Disk as deep as broad; its greatest width about opposite middle of its length. Head large, with produced, pointed snout; snout about

$2\frac{3}{4}$ in disk, and anterior margins of disk, concave; eyes very small, slightly elevated, and about equal to $5\frac{1}{2}$ in interorbital space; nostrils large, confluent, except for thick cartilaginous frenum, and with edges of flap fringed; mouth small, about $1\frac{1}{4}$ in space between nostrils, and $4\frac{2}{5}$ in snout; teeth in somewhat roughened, pavement-like patches in jaws; interorbital space concave in middle, elevated a little on both sides, and equal to 3 in snout. Spiracles very large, rounded, and equal to $2\frac{1}{2}$ eye diameters. Gill-openings moderately small.

Body entirely smooth, with exception of upper surface of tail behind spine, where it is roughened.

Base of ventral about $1\frac{2}{5}$ in interorbital space; tail very long and slender, greatly exceeding length of disk; width of tail at base, $2\frac{1}{4}$ in interorbital space; spines on upper part of tail, less than interorbital space, sharp, slender, serrate on both of outer edges, and inserted about first fifth the length of tail; rather low keels on tail, one above short, and behind spine, the lower much longer.

Color in alcohol, brown above, more or less uniform, and below, whitish.

Length, $29\frac{1}{2}$ inches.

This description from a specimen from Kobe.

In a young specimen, with two caudal spines, the eyes are larger, the tail is smooth and with keels long, and the color darker above, and more or less mottled indistinctly.

Coasts of Japan and southward, known by the long snout. Our specimens from Tokyo, Kobe, Wakanoura, Onomichi, and Hiroshima.

(*zug-ei*, the Japanese name.)

50. DASYATIS GERRARDI (Gray).

Trygon gerrardi Gray, Chondropt., 1851, p. 116; India.—Günther, Cat. Fish, VIII, 1870, p. 474; Japan, East Indies.

Trygon macrurus Bleeker, Verh. Bat. Gen., XXIV, 1852, Plag., p. 74; Java, Sumatra.—Duméril, Elasmobranches, 1870, p. 588 (after Bleeker).

Disk broader than long. Snout rather obtuse, margins forming an obtuse angle. One or more large tubercles in center of back, round which, or in front of which, generally smaller tubercles are grouped, forming a small patch or short band, and not extending beyond central portion of disk. Tail without cutaneous fold, exceedingly long and slender, about thrice as long as disk, without tubercles at base. Color brown, with round, yellowish spots, limited to posterior parts in young examples, which have tail ornamented with alternate brown and yellow rings. (Günther.)

India, East Indies, and a half-grown specimen recorded from Japan by Dr. Günther. We have seen no Japanese specimens. A related

species *D. nudus* (Günther), known by the smooth skin, is listed by Bleeker as from Japan, but no locality is given.

Duméril finds 2 buccal papillæ.

(Named for M. Gerrard.)

41. PTEROPLATEA Müller and Henle.

Pteroplatea Müller and Henle, Plagiostomen, 1838, p. 168 (*altavela*).

Disk much broader than long, its anterior margins meeting in a very obtuse angle, its outer angles more or less acute, the form, therefore, transversely rhombic. Tail very short and slender, shorter than the disk, without fin, armed with a very small, serrated spine, which is often wanting. Skin smooth, or very nearly so. Size rather large. Warm seas. The species are closely related.

(πτερόν, fin; πλατύς, broad; an ancient name of *Pteroplatea altavela.*)

51. PTEROPLATEA JAPONICA (Schlegel).

TSUBAKUROEI (SWALLOW RAY); YOKOSAEI (CROSS-WISE RAY).

Pteroplatea japonica Schlegel, Fauna Japonica, Poiss., 1850, p. 309, pl. CXLI; Nagasaki.—Bleeker, Act. Soc. Sci. Indo. Neerl., III, 1857, Japan, IV, p. 45.—Duméril, Elasmobranches, 1870, p. 614.

Dasyatis micrura var. japonicus Gray, Chondropt., 1851, p. 122; Japan, Canton.

Pteroplatea hirundo, Ishikawa, Prel. Cat. 1897, p. 60; Tokyo, Boshu; (not of Lowe).

Disk very broad, its length only a little more than half its width; its greatest width would fall about opposite last fourth of its length. Head very broad, and flattened; snout only a small, blunt point, and its length equal to two-thirds interorbital space; anterior margin of disk broadly convex; eyes small, somewhat elevated, 7 in interorbital space; nostrils large, well separated, with large flaps; mouth moderate, equal to its length from tip of snout, undulate; teeth in broad, pavement-like patches in jaws; interorbital space very broad, flattened. Spiracles directly behind eye, much larger than the same. Gill-openings moderate.

Body entirely smooth.

Base of ventral $1\frac{3}{4}$ in interorbital space; tail very small, short, its length about twice interorbital width; a small, weak spine on upper surface of tail at its first third.

Color in alcohol, olivaceous brown above, marked with very fine, numerous, darker punctuations, tail whitish with eight dark rings about as broad as interspaces; lower surface of body whitish.

Length, $9\frac{1}{4}$ inches.

Here described from a female from Wakanoura.

Coasts of Japan, rather common. It was taken at Tokyo, Wakanoura, Hiroshima, Hakata, Kawatana, and Nagasaki.

Family XXI. MYLIOBATIDÆ.

EAGLE RAYS.

Disk broad; the pectoral fins not continued to the end of the snout, ceasing on the sides of the head and reappearing in front of the ut as 1 or 2 fleshy protuberances (cephalic fins), which are sup- rted by fin rays. Tail very long and slender, whip like, with a gle dorsal fin near its root, behind which is usually a strong, rorsely serrated spine. Nasal valves forming a rectangular flap, h the posterior margin free, attached by a frenum to the upper . Skull less depressed than usual among rays, its surface raised that the eyes and spiracles are lateral in position. Teeth hexangu- , large, flat tessellated, the middle ones usually broader than the ers. Ovoviviparous. Skin smooth; no differentiated spines on pectorals in the males, the sexes being similar. Ventrals not arginate. Large sting rays; inhabiting warm seas, feeding chiefly mollusks, which they crush with their large, grinding teeth.

Teeth in several series, the middle series very broad.
Muzzle entire .... *Myliobatis*, 42

42. MYLIOBATIS Duméril.

Myliobatis Duméril in Cuvier, Règne Animal, 1st ed., II, 1817, p. 137 (*aquila*).
Holorhinus Gill, Proc. Ac. Nat. Sci. Phila., 1862, p. 331 (*vespertilio=californicus*).

Disk broad, the outer angles acute. Cephalic fins, forming a soft, ivex appendage in front of snout. Jaws about equal. Median th very broad, much broader than long in the adult, proportionally rrower in the young. Several series of narrower teeth on each side the median series; teeth changing considerably with age. Free ge of the nasal valve not deeply emarginate. Tail very long and nder, with a small dorsal fin, and one or more serrated spines. in smooth, or nearly so. Size large. In all warm seas. (μύλος, grinder; βάτις, ray.)

Disk two-thirds as long as broad .... *tobijei*, 52.
Disk twice as broad as long .... *nieuhofi*, 53.

52. MYLIOBATIS TOBIJEI Bleeker.

TOBI-EI (KITE RAY, OR FLYING RAY).

Myliobatis aquila Schlegel, Fauna Japonica, 1847, p. 310, pl. cxlii; Nagasaki (not of Linnæus).
Myliobatis tobijei Bleeker, Verh. Bat. Gen., XXVI, 1854, Nieuwe Nalez. Japan, p. 130; Nagasaki.—Duméril, Elasmobranches, 1870, p. 640 (after Bleeker).
Myliobatis cornuta Günther, Cat. Fish, VIII, 1870, p. 490; Japan.—Ishikawa, Prel. Cat 1897, p. 60, Matsushima.

Head 3 in body (from tip of snout to base of ventrals behind), snout n head, eye 6 in interorbital space; spiracles $2\frac{1}{2}$; width of mouth $2\frac{1}{4}$.

Disk very broad, length of body from tip of snout to tip of ventral a little more than $1\frac{1}{2}$ in its greatest width. Head thick, depressed and rounded above; snout flexible, inferior, flattened, and rounded; eyes small, lateral, at some distance in advance of spiracles; nostrils large, rather close together, separated by thick, cartilaginous and fleshy frenum, which is coarsely papillose or warty; lips and nasal flaps very thick and fleshy; teeth in pavement-like plates; interorbital space broad, fontanelle hollow in middle, and on each side of this a little elevated and flattened. Spiracles large, oblique. Gill-openings moderate.

Body smooth.

Dorsal fin small, its base a little less than length of spiracle, inserted behind ventrals; caudal very long, filamentous; upper surface of tail with a compressed, pointed spine with serrated edges a little less in length than space between spiracles; ventrals long and free, bases rather narrow.

Color in alcohol, dusky brown above, with many rather large, whitish spots, distinct posteriorly; lower surface chalky white; tail blackish.

Total length, $54\frac{1}{2}$ inches; without tail, about 10 inches.

Description from a male taken at Tokyo.

Coasts of southern Japan, not uncommon. Our specimens from Hakodate, Tokyo, Onomichi, Hiroshima, Hakata, and Nagasaki. Some of these have the dermal thickening, or horn, over the eye, said to characterize *M. cornuta*, and others are without it. This is evidently not a specific character.

(*tobi-ei*, Flying Ray in Japanese.)

53. MYLIOBATIS NIEUHOFI (Bloch and Schneider).

Raja nieuhofii BLOCH and SCHNEIDER, Syst. Ichth., 1801, p. 364; Indian Sea (after Zee-Vleermuis of Nieuhof, in Willughby, Appendix, p. 6, pl. x, fig. 3).

Myliobatis nieuhofii CUVIER, Règne Anim., 1st ed., 1817, p. 138.—MÜLLER and HENLE, Plagiostomen, 1838, p. 177.—DUMÉRIL, Elasmobranches, 1870, p. 638; Pondicherry.—GÜNTHER, Cat. Fish, VIII, 1870, p. 491; Pinang, Moluccas, Japan.

Raja fasciata SHAW, Gen. Zool., III, 1804, p. 286, pl. CXLIII (after Schneider).

Body smooth, disk about twice as broad as long. Fleshy prolongation of snout, short; no horn on orbit. Dorsal situated at beginning of base of tail, opposite end of insertion of ventrals, no spines posterior to it; tail about three times as long as disk. Color, olive superiorly, tinged externally with a reddish hue, and a dark, outer margin to disk; young have about seven blue bands across disk and two more between or close to eyes; as fish increases in size first bands on head disappear, and finally those on body. (Günther, Day.)

Indian Ocean and archipelago; a half-grown specimen in the British

Museum, said to be from Japan (coll. Jamrach). The record is very doubtful, but the species, if occurring in Japan, may be recognized by the anterior position of the dorsal fin, nearly over the root of the ventrals and by the very broad disk. It was not seen by us.

(Named for Dr. Jean Nieuhof, of Batavia, died in 1671, once governor of Ceylon, author of Voyages par mer et par terre à differens lieux des Indes Orientales, with 20 plates of fishes.

Family XXII. MOBULIDÆ.

SEA DEVILS.

Rays of enormous size, with the disk broader than long, and the pectoral fins not continued on the sides of the head, the anterior or cephalic portion being separate, developed as 2 long horn-like or ear-like appendages. Mouth wide, terminal or inferior. Teeth very small, flat or tubercular, in many series; those of the upper jaw sometimes wanting. Eyes lateral. Nostrils widely separated, their valves united, forming a flap as wide as the cleft of the mouth. Tail long and slender, whip-like, with a single dorsal fin at its base, and with or without a serrated spine. Ventral fins not emarginate. Skin more or less rough. Males without differentiated spines on the pectorals, the sexes similar. Ovoviviparous. Largest of all rays and among the largest of all fishes; the species few, found in the tropical seas.

a. Teeth in both jaws; mouth inferior .... *Mobula*, 43

43. MOBULA[a] Rafinesque.

Mobula RAFINESQUE, Indice d'Ittiol. Sicil., 1810, p. 61 (*auriculata=edentula*).
Apterurus RAFINESQUE, Indice d'Ittiol. Sicil., 1810, p. 62 (*fabroni=edentulus*).
Cephalopterus DUMÉRIL, in Risso Ichthyol., Nice, 1810, p. 14 (*giorna=edentula;* not of Geoffroy St. Hilaire, 1809, a genus of birds).
Dicerobatus BLAINVILLE, Jour. de Phys., 1816, p. 262 (*mobular=edentula*).
Cephaloptera (Duméril) CUVIER, Règne Animal, 1st ed., II, 1817, p. 138 (*giorna*).
Pterocephala SWAINSON, Nat. Hist. Fishes, II, 1839, p. 321 (*giorna*).

Head free from pectoral fin, truncated in front, with the cephalic fin on each side developed as a straight, horn-like appendage, pointing forward. Nostrils widely separated. Mouth inferior, wide. Teeth in both jaws very small, flat, or tubercular, in many series. Tail very slender, with a dorsal fin between the ventrals; the serrated spine present or absent. Species about 5, in tropical seas, reaching an enormous size and therefore not well known.

(*Mobular* is a name said to be used for the European species, *Mobula edentula* (Brünnich), "le diable des Caraïbes," in the Azores.)

[a] The name *Aodon*, accepted for this genus by Jordan and Evermann, was originally based on a shark of the Red Sea, *Aodon massasa*, said to have microscopic, serrated teeth, and very large pectoral fins. It may belong to the *Scylorhinidæ*.

54. MOBULA JAPONICA (Müller and Henle).

ITOMAKI-EI (SPOOL RAY).

Cephaloptera japonica MÜLLER and HENLE, Plagiostomen, 1836, p. 185; Nagasaki.—SCHLEGEL, Fauna Japonica, 1850, p. 310; Nagasaki.—DUMÉRIL, Elasmobranches, 1870, p. 659 (after Müller and Henle).

Dicerobatis japonica GÜNTHER, Cat. Fish, VIII, 1870, p. 496 (after Müller and Henle).

Teeth very minute, obtuse tubercles, extending laterally to the angles of the mouth. Back rough. Tail nearly thrice as long as

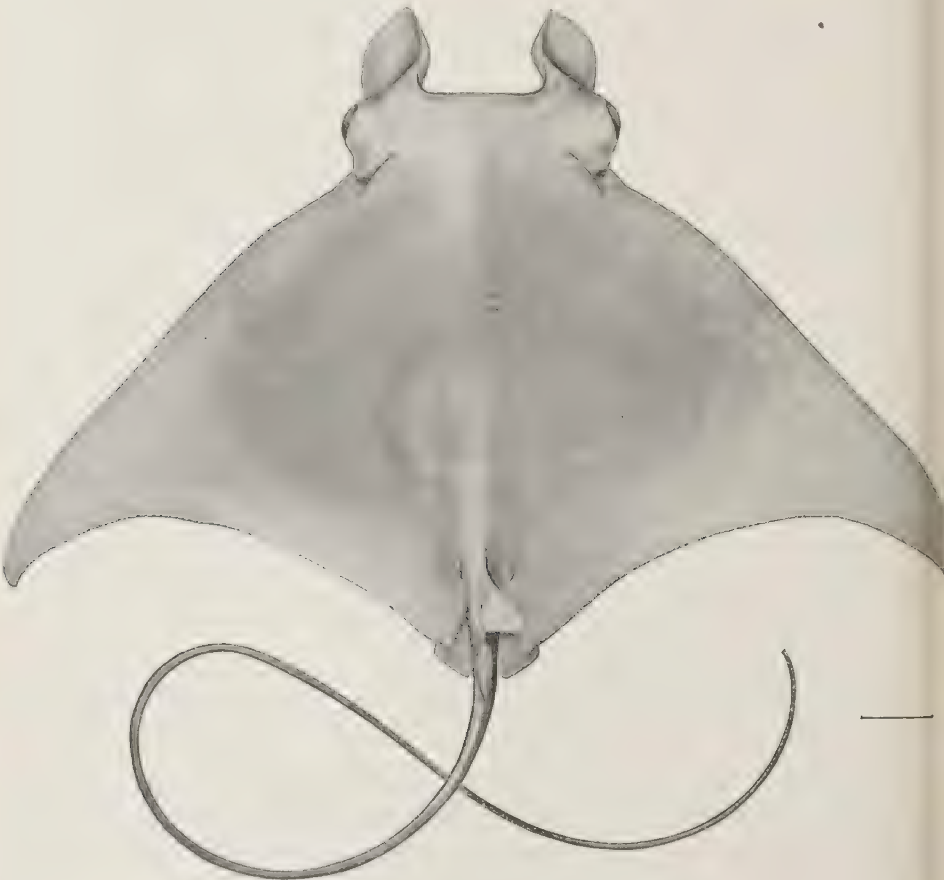

FIG. 10.—MOBULA JAPONICA (from a fœtus).

body. On each side of tail, a series of small, white tubercles. (Günther, after Müller and Henle.)

Coasts of Japan, occasionally taken. A fetus, 22¼ inches long, was obtained by us from Kumakichi Aoki of Misaki. Two mounted specimens are in the museum at Hakodate, both from Volcano Bay. The largest is 8 feet across, the tail about twice the length of disk, which is a little more than twice as broad as long.

Subclass HOLOCEPHALI.

CHIMÆRAS.

Skeleton cartilaginous. Gill cavity with four clefts within, but having one external opening only, which is covered by a fold of skin. No spiracles. Mouth inferior. Jaws with teeth, confluent into bony plates; upper jaw, palate, and hyomandibular, coalescent with the skull; intestine with a spiral valve. Pectoral fins normally developed, placed low; ventral fins abdominal, with claspers in the male; a cartilaginous hook, with a brush of teeth at the tip (frontal holder) on the forehead of the adult male. Derivative radii sessile on the sides of the basal bones of the limbs. Skin scaleless, its muciferous system well developed. This group contains a single order, Chimæroidei, among existing fishes; many extinct forms belong to it, and the group is perhaps not less ancient than that of the sharks.

(ὅλος, solid; κεφαλή, head.)

Order V. CHIMÆROIDEI.

CHIMÆROIDS.

Characters of the order, included above. The group includes three existing families, Rhinochimæridæ (Bassalian), Chimæridæ, and Callorhynchidæ (Antarctic). The two families found in Japan are thus defined by Mr. Garman:

a. Proboscis long and pointed; lateral canal system subtubular; notochord with rings; cerebral hemispheres distant from both olfactory and optic lobes.
RHINOCHIMÆRIDÆ, XXIII.

aa. Proboscis absent; lateral canal system, sulcate; notochord with ring-like segments; cerebral hemispheres fused with the olfactory lobes, and distant from the optic lobes .... CHIMÆRIDÆ, XXIV.

Family XXIII. RHINOCHIMÆRIDÆ.

Snout very long, with a cartilaginous midrib, and foliaceous lateral expansions of the skin at the base. Two dorsal fins, the anterior one with an immense triangular spine, finely serrated on its lateral edges. Tail very elongate, with filamentous tip. Frontal region in the adult male with a "frontal holder," as in Chimæra. Ventral claspers small and simple, gill-openings separated by a wide isthmus. Lateral canal system subtubular; notochord with rings; cerebral hemispheres distant from both olfactory and optic lobes. Two genera—*Harriotta* in the deep waters below the Gulf Stream, and *Rhinochimæra* in similar situations in Japan. *Harriotta* has teeth much like those of *Chimæra*. *Rhinochimæra* is the most primitive of existing Chimæroids.

44. RHINOCHIMÆRA Garman.

Rhinochimæra Garman, Proc. N. Eng. Zool. Club, 1901, II, p. 75 (*pacifica*).

Teeth without tritors or dental lamina, much like the horny covers of the jaws of tortoises or birds. Snout stronger and more compressed than in *Harriotta*. Japan, in deep seas.

(*ῥίν*, snout; *χιμαίρα*, chimæra.)

55. RHINOCHIMÆRA PACIFICA (Mitsukuri).

Harriotta pacifica Mitsukuri, Zool. Mag., June, 1895, pl. xvi; Kurihama, near Misaki.

Rhinochimæra pacifica Garman, Proc. N. Eng. Zool. Club, 1901, p. 75 (specimen bought in Japan).

No detailed description of this species has yet been given. Mitsukuri's paper reads as follows:

The reader's attention is called to Plate XVI, giving the figures of individuals of the Chimæroid group. The lower figure is copied, somewhat reduced, from the April number of the American Naturalist, and represents the new chimæroid *Harriotta raleighana*, which Messrs. Goode and Bean discovered among the collection made by the *Albatross*. Its habitat is said to be the coasts of Virginia, Maryland, and Delaware, 707–1080 fathoms.

The upper figure represents a chimæroid which has been for some years in the possession of the Zoological Museum of the Science College in the Imperial University of Tokyo. The specimen (male) was bought in the Tokyo market and is marked as from *Kurihama, province of Sagami*. There can be no doubt that fishermen of that village caught it in the deep water (200 fathoms or more) contiguous to Misaki. Its unique characters had not been noted by us.

Unfortunately, I am not yet in possession of the original description of *Harriotta raleighana* by Messrs. Goode and Bean; but the short description, the extremely elongate muzzle, and the feeble claspers, as well as a comparison of the two figures, leave no doubt in my own mind that the individuals figured belong to the same genus.

There can be very little question that they belong to different species. (1) The general shape of the body, (2) the shape and size of the pectoral and ventral fins, (3) the point to which these fins reach when back, (4) the shape and disposition of the dorsal fins, (5) distribution of lateral-line sense system, all seem to point to the specific distinction of Atlantic and Pacific specimens. The name of *Harriotta pacifica* will be appropriate to the Japanese species.

I hope to return to the subject and to give fuller notes at no distant date. The occurrence of this interesting genus in both the Pacific and Atlantic oceans is, however, an interesting fact well worthy of being placed on record as speedily as possible.

Of this species a few specimens have been obtained by Professor Mitsukuri in deep water off Misaki. These the senior author has examined, but has not minutely described.

Family XXIV. CHIMÆRIDÆ.

CHIMÆRAS.

Body elongate, rather robust anteriorly, tapering posteriorly. Head compressed, without proboscis, mouth small, inferior, the upper lip deeply notched. Nostrils confluent with the mouth, separated by a narrow isthmus; jaws with the teeth confluent into 4 bony laminæ

(tritors) above and 2 below. No spiracles. Pectorals free, placed low; ventral fins abdominal, many rayed, provided in the male with claspers, the male also with "frontal holders" on the forehead. Dorsal fin usually divided, anteriorly with a very strong spine, which is grooved behind; caudal fin low, fold-like. Skin naked, rarely, somewhat prickly. Lateral line present, usually with numerous branches anteriorly, the canal system, sulcate. Notochord with ring-like segments. Cerebral hemispheres fused with the olfactory lobes, and distant from the optic lobes. (Garman.)

Three free gills and 2 half gills, 1 on each side; isthmus moderate; gill-rakers small. Oviparous, the egg cases long, elliptical, with silky filaments. Fishes of singular appearance, found only in the seas of the cold regions.

45. CHIMÆRA Linnæus.

ELEPHANT FISHES.

Chimæra LINNÆUS, Syst. Nat., 10th ed., 1758, p. 236 (*monstrosa*).
Hydrolagus GILL, Proc. Ac. Nat. Sci. Phila., 1862, p. 331 (*colliei*).

Head somewhat compressed, the snout bluntish, protruding, fleshy, not armed at tip with an appendage. Eyes very large, lateral. Teeth rather strong. Lips thickish, the lower with a frenum. Lateral line simple on the body, but forking anteriorly, forming several series of mucous tubes on the head. Male with a club-shaped, cartilaginous hook on the head above the snout; this hook is curved forward and downward, and is armed at its tip with decurved spines, its tip fitting into a depression in front of the eyes; females without this appendage. Gill-opening small. Pectorals moderate; ventrals rather large, with large bifid or trifid claspers in the male, the form partly dependent on age or season; male also with rough appendages at the base of the ventrals, protruding from a sheath of skin. First dorsal triangular, preceded by a strong spine, which is grooved behind and serrated on its edges; second dorsal and caudal fins low, often more or less notched. Tail extending in the line of the axis of the body, often more or less produced in a filament at tip. Skin smooth. Fishes of singular appearance; mostly of the northern seas; not valued for food.

(*χίμαιρα*, chimæra, a fabulous monster, with the head of a lion, body of a goat, and tail of a serpent.)

56. CHIMÆRA PHANTASMA Jordan and Snyder.

GINZAME (SILVER SHARK).

Chimæra monstrosa SCHLEGEL, Fauna Japonica, Poiss., 1850, p. 300, pl. CXXXII; Nagasaki (not of Linnæus).
Chimæra phantasma JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1900, p. 338; Tokyo.

Body very elongate, tapering from head into the long, filamentous tail. Head deep, oblong, its width about three-fifths its length, its

depth less than length; snout very deep, blunt, rounded, short, soft; eyes oblong, large, high, a little anterior, their length 3 in head (measured from surrounding cartilages); hook on tip of head in front of snout, depressible in sockets, and with its lower rounded extremity beneath, beset with many sharp spines, directed backward; mouth small, inferior, with thick lips; teeth of 10 laminæ in upper jaw, forming a serrate cutting edge in front, and posteriorly broad, oblique, molar-like teeth are found; in mandible, 16 laminæ, forming a serrate cutting edge in front, laminæ becoming broad posteriorly and with a concave space in front at symphysis; no broad, posterior, molar-like teeth on mandible, edges of jaws elevated and enameled; nostrils large, close together, confluent with corners of mouth; space between eyes narrow, less than their diameter. Gill-openings small, in front of and below base of pectoral; isthmus broad, with a fold of skin across.

First dorsal arising directly behind head, armed with a long, curved, compressed, pointed spine, much longer than fin, when depressed, 7 times length of pupil, triangular in cross section, keeled in front, with a serrate edge, posterior edge, from its separation from the soft part of fin, grooved in middle, and with each of edges finely serrate; first dorsal is depressible in a deep groove; second dorsal long, even, of uniform height to base of upper caudal lobe; upper caudal lobe not so high as second dorsal, shorter than lower lobe, sinking on fin anterior to it; pectorals very long, broad at base, pointed, not reaching tips of claspers; ventrals inserted behind tip of dorsal spine, broad, rounded, about equal to length of head; lateral line running around eye above and below, over the top of head, joined behind eyes and along sides superiorly.

Color in alcohol, brown above, white below, and washed with silvery; fins with their outer portions blackish.

Total length, 29⅜ inches; without caudal filament, 19⅜ inches.

This description is from a male taken in Sagami Bay. It differs from two other specimens from the same locality, and from the original type, in having the anal and caudal lobe below, confluent, and forming a single fin.

This species is not rare in rather deep water along the coast of Japan. We have secured three specimens from Misaki, besides the original type found by Mr. Otaki in the market of Tokyo.

(*φαντάσμα*, a vision.)

SUPPLEMENTARY NOTE.

In a recent letter (January, 1903) Dr. K. Kishinouye notes the discovery of the East Indian shark *Stegostoma tigrinum* (Gmelin), on the coast of Japan, near Tokyo. It belongs near the *Hemiscylliidæ*, being remarkable for the very long tail, half the length. Body with brown spots or bands.

SUMMARY.

Class ELASMOBRANCHII.

Subclass Selachii.

Order I. Notidani.

Family I. Hexanchidæ.

1. *Heptranchias* Rafinesque.

1. *deani* Jordan and Snyder; *Aburazame;* Misaki.

Family II. Chlamydoselachidæ.

2. *Chlamydoselachus* Garman.

2. *anguineus* Garman; *Rabuka, Kagurazame;* Misaki.

Order II. Asterospondyli.

Family III. Heterodontidæ.

3. *Heterodontus* Blainville.

3. *japonicus* (Duméril); Misaki, Tokyo, Wakanoura, Kobe, Hakata, Nagasaki.

Family IV. Scyliorhinidæ.

4. *Halælurus* Gill.

4. *burgeri* (Müller and Henle); Nagasaki.

5. *Cephaloscyllium* Gill.

5. *umbratile* Jordan and Fowler; *Nanukazame, Oseibuka;* Nagasaki.

Family V. Hemiscyllidæ.

6. *Chiloscyllium* Müller and Henle.

6. *indicum* (Gmelin); Keerun in Formosa.

7. *Orectolobus* Bonaparte.

7. *barbatus* (Gmelin); Nagasaki, Hakata.

7a. *Stegostoma* Müller and Henle.

7a. *Tigrinum* (Gmelin); not seen.

Family VI. Carchariidæ.

8. *Mustelus* Cuvier.

8. *manazo* Bleeker; *Hoshizame;* Hakodate, Aomori, Matsushima, Tokyo, Misaki, Kobe, Onomichi, Hiroshima, Hakata.

9. *Triakis* Müller and Henle.

9. *scyllium* Müller and Henle; *Korozame;* Tokyo, Tsuruga, Onomichi, Hakata.

10. *Galeus* Rafinesque (*Galeorhinus* Blainville).

10. *japonicus* (Müller and Henle); *Yerakufuka;* Nagasaki, Onomichi, Hiroshima.

11. *Galeocerdo* Müller and Henle.

11. *tigrinus* Müller and Henle; Nagasaki.

12. *Prionace* Cantor.

12. *glauca* Linnæus; Misaki.

13. *Carcharias* Rafinesque (*Carcharhinus* Blainville).

13. *japonicus* (Schlegel); *Mejiro, Wanizame;* Hakodate, Tokyo, Wakanoura, Kawatana, Nagasaki.

14. *Scoliodon* Müller and Henle.

14. *laticaudus* (Müller and Henle); not seen.
15. *acutus* (Rüppell); not seen.
16. *walbeehmi* (Bleeker); Nagasaki, Kawatana.

Family VII. Sphyrnidæ.

15. *Sphyrna* Rafinesque.

17. *zygæna* (Linnæus); *Shimokuzame, Kasebuzame;* Misaki, Wakanoura, Nagasaki.

Family VIII. Alopiidæ.

16. *Alopias* Rafinesque.

18. *vulpes* (Gmelin); *Onogazame, Nadebuka, Nezumezame;* Tokyo, Yokohama, Nagasaki.

Family IX. Mitsukurinidæ.

17. *Mitsukurina* Jordan.

19. *owstoni* Jordan; Misaki.

Family X. Lamnidæ.

18. *Isuropsis* Gill.

20. *glauca* (Müller and Henle); *Aozame, Morozame;* Matsushima, Nagasaki.

19. *Lamna* Cuvier.

21. *cornubica* (Gmelin); not seen.

20. *Carcharodon* A. Smith.

22. *carcharias* (Linnæus); Misaki.

Family XI. Cetorhinidæ.

21. *Cetorhinus* Blainville.

23. *maximus* (Gunner); *Ubazame, Tenguzame, Bakazame, Zozame;* not seen, but reported on good authority.

Family XII. Rhineodontidæ.

22. *Rhineodon* A. Smith.

24. *typicus* Smith (*pentalineatus* Kishinouye); not seen.

Order III. Tectospondyli.

Family XIII. Squalidæ.

23. *Squalus* Linnæus.

25. *mitsukurii* Jordan and Snyder; Aomori, Misaki, Awa, Kagorhima, Boshu.

24. *Lepidorhinus* Bonaparte

26. *foliaceus* (Günther); Misaki.

25. *Deania* Jordan and Snyder.

27. *eglantina* Jordan and Snyder; Totomi Bay.

26. *Zameus* Jordan and Fowler.

28. *squamulosus* (Günther); Misaki.

27. *Etmopterus* Rafinesque.

29. *lucifer* Jordan and Snyder; *Bozuzame;* Misaki.

28. *Centroscyllium* Müller and Henle.

30. *ritteri* Jordan and Fowler; Misaki.

Family XIV. Dalatiidæ.

29. *Dalatias* Rafinesque.

31. *licha* (Bonnaterre); *Yoroizame;* Misaki.

30. *Somniosus* Le Sueur.

32. *microcephalus* (Bloch and Schneider); Tokyo.

Family XV. Pristiophoridæ.

31. *Pristiophorus* Müller and Henle.

33. *japonicus* Günther; *Nokogirizame, Hokobuka, Daigirizame,* Aomori, Nagasaki.

Family XVI. Squatinidæ.

32. *Squatina* Duméril.

34. *japonica* Bleeker; *Tengaizame, Kasuzame, Korozame;* Nagasaki, Kobe.

Order IV. Batoidei.

Family XVII. Rhinobatidæ.

33. *Rhina* Bloch and Schneider.

35. *ancyclostomus* Bloch and Schneider; Kinkwazan, Matsushima Bay.

34. *Rhynchobatus* Müller and Henle.

36. *djiddensis* (Forskål); *Tongari, Kotainozu, Kasuka, Shinosaki, Sakafute;* Onomichi, Hiroshima, Hakata, Tsuruga.

35. *Rhinobatus* Bloch and Schneider.

37. *schlegeli* Müller and Henle; *Sakatazame;* Tokyo, Wakanoura, Onomichi, Hakata, Nagasaki.

38. *polyophthalmus* Bleeker; Wakanoura, Hiroshima, Hakata, Nagasaki.

Family XVIII. Rajidæ.

36. *Discobatus* Garman.

39. *sinensis* (Bloch and Schneider); *Uchiwazame;* Hiroshima, Wakanoura.

37. *Raja* Linnæus.

40. *isotrachys* Günther; not seen.
41. *fusca* Garman; not seen.
42. *meerdervoorti* Bleeker; *Sebita;* Tokyo, Nagasaki, Kobe, Wakanoura, Hakodate.
43. *kenojei* Schlegel; *Kenoei, Gengiei, Kasube, Igaëi, Rentiei;* Misaki, Tokyo, Wakanoura, Kobe, Tsuruga, Nagasaki.
44. *tengu* Jordan and Fowler; *Tenguei;* Aomori, Hakodate, Matsushima.

Family XIX. Narcobatidæ.

38. *Astrape* Müller and Henle.

45. *japonica* Schlegel; *Shibireei;* Wakanoura.

Family XX. Dasyatidæ.

39. *Urolophus* Müller and Henle.

46. *fuscus* Garman; *Junoruei;* Tokyo, Kobe, Hiroshima, Hakata, Wakanoura.

40. *Dasyatis* Rafinesque.

47. *kuhlii* (Müller and Henle); Tokyo, Misaki, Hakodate, Wakanoura, Onomichi, Hiroshima.
48. *akajei* (Müller and Henle); *Akaëi;* Matsushima, Tokyo, Misaki, Wakanoura, Onomichi, Hiroshima, Tsuruga, Hakata, Kawatana, Nagasaki.
49. *zugei* (Müller and Henle); *Zugei;* Tokyo, Kobe, Wakanoura, Onomichi, Hiroshima.
50. *gerrardi* (Gray); not seen.

41. *Pteroplatea* Müller and Henle.

51. *japonica* (Schlegel); *Tsubakuraëi, Yokosaëi;* Tokyo, Wakanoura, Hiroshima, Hakata, Kawatana, Nagasaki.

Family XXI. Myliobatidæ.

42. *Myliobatis* Duméril.

52. *tobijei* Bleeker; *Tobiei;* Hakodate, Tokyo, Onomichi, Hiroshima, Hakata, Nagasaki.
53. *nieuhofi* (Bloch and Schneider); not seen.

Family XXII. Mobulidæ.

43. *Mobula* Rafinesque.

54. *japonica* (Müller and Henle); *Itomakiei;* Misaki, Volcano Bay.

Subclass Holocephali.

Order V. Chimæroidei.

Family XXIII. Rhinochimæridæ.

44. *Rhinochimæra* Garman.

55. *pacifica* (Mitsukuri); Kurihama, Misaki.

Family XXIV. Chimæridæ.

45. *Chimæra* Linnæus.

56. *phantasma* Jordan and Snyder; *Ginzame;* Sagami Bay, Tokyo.

THE CEREBRAL FISSURES OF THE ATLANTIC WALRUS.

By Pierre A. Fish,
Of Cornell University, Ithaca, New York.

Through the courtesy of the officials of the U. S. National Museum there were sent to me, for examination and description, two walrus brains obtained for that institution by R. Stein at North Greenland, August 10, 1901. The specimens had been preserved in a fluid of which formaldehyde was apparently a constituent. In both brains the cerebellum had been removed by a section through the brain stem at the level of the junction of the optic thalami with the mesencephal, so that in the process of removal the epiphysis (pineal body) remained attached to the cerebellar portion; the two hemicerebrums were then divided by a median section.

The two brains differed quite markedly in size, the one being but slightly more than half as large as the other. The smaller of the two brains had suffered quite material mutilation during its removal from the cranium, a considerable portion of the brain substance having been lost from the right hemicerebrum. In the process of hardening all of the hemicerebrums had undergone considerable distortion. The mesal surface in each case, instead of being relatively flat, was very distinctly convex in its cephalo-caudal direction, and on this account the gyres (convolutions) and fissures of the lateral aspect were closely crowded together, rendering the study of these parts more difficult. On this account, also, it was decided not to photograph the brains, as the relationship of the parts would be misleading and tend to cause error and confusion to the observer. The figures which illustrate this article were sketched free-hand, the parts at the same time being manipulated so as to bring them as nearly as possible to their normal relations. By carefully verifying each part on the brain itself as the drawing progressed, it is believed the figures may be accepted as representing with approximate accuracy the normal relationship of the more important parts.

Weight. Turner[a] gives the weights of three walrus brains "after

[a] Challenger Reports, Zoology, XXVI, 1888, pp. 89–134.

the removal of the membranes and hardening in spirit." Brain A weighed 24 ounces 7 drams avoirdupois; B 13½ ounces, and C 26 ounces. In the specimens examined by me only the larger of the two brains was weighed, all of the membranes having been removed from the cerebrum, but not from the cerebellum and the brain stem adjacent to it, the pia and arachnoid still adhering. The total weight of the brain under these conditions was 29 ounces avoirdupois. The weight of the cerebrum without the pia was 22¾ ounces, leaving a weight of 6¼ ounces for the cerebellum, oblongata, mesencephal, and epiphysis, the latter having adhered to the cerebellum. Turner has called attention to the remarkable size and leaf-like or pyriform shape of the epiphysis (pineal body) in the walrus, but does not mention its weight. In my specimen it weighed 1 dram, 1 scruple, and 3 grains, or a total of 83 grains.

FISSURES AND GYRES.

The olfactory fissure is scarcely represented; a slight, short depression at the attachment of the olfactory peduncle is all that can be found. The olfactory bulbs were missing, but the peduncles have about the same size as those in Callorhinus aad Monachus, and are relatively much smaller than in the bear.

The rhinal fissure is well developed. The olfactory peduncle for most of its length lies in this fissure. At the base of the peduncle the rhinal swerves obliquely in a caudo-lateral direction and is lost in the depths of the sylvian. It reaches a considerable depth under the presylvian lobe (sub-operculum).

The post rhinal is represented upon the ventral surface as a short spur or outcrop of the submerged postica, resembling in this respect the condition found in Zalophus, Callorhinus, and Monachus. In Ursus and Phoca the post rhinal is a continuation of the rhinal caudad of the sylvian.

Lateral aspect. The sylvian points in the usual dorso-caudal direction on the lateral surface. It is a straight fissure, and does not bifurcate at its end. It measures 60 millimeters in length, and has a depth ranging from 20 to 30 millimeters. It is the deepest fissure of the brain, extending to within 5 millimeters of the lateral ventricle (paracœle). On opening the sylvian fissure one sees a fissure, the presupersylvian, quite near the lateral surface of the hemicerebrum. The two fissures run nearly parallel with each other, but diverge dorsally where the presupersylvian becomes an ordinary surface fissure. From three to six minor submerged fissures are found in the cephalic wall of the sylvian. These pass upward toward the surface, and some have a superficial connection with the presupersylvian, but the majority usually do not appear upon the lateral aspect of the brain. Submerged minor fissures also appear in the caudal wall of the sylvian. These in general have the

same form and direction as those in the cephalic wall. One striking exception with regard to the direction of the submerged fissures I have called attention to in a preceding paper.[a] This fissure I have compared with the postica. It corresponds to a fissure of the same name in the feline brain, but differs in this instance, in that it is submerged in the sylvian. Ursus, Zalophus, Callorhinus, and Phoca also show this peculiarity. The postica differs from the other submerged fissures of the sylvian by extending in a direction at nearly right angles to them, that is, dorso-ventrally, paralleling approximately for a short distance that of the sylvian itself.

The true insula is but scarcely developed in the walrus, and appears merely as a slight elevation in the bottom of the sylvian fissure. The submerged gyre formed by the postica fissure may easily be mistaken for a well-developed insula, as it has approximately a suitable location. Whether the submerged gyre later forms a closer relationship with the true insula, and is the precursor of the more complicated insula found in the higher forms, is a question that can not be answered here. Ziehen[b] describes in the walrus a well-developed insula divided by fissures into three gyres.

Supersylvian fissure.—This fissure arches around the distal end of the sylvian in the usual way. Its frontal portion—the presupersylvian—passes close to the sylvian, converging gradually until near the base of the sylvian the presupersylvian becomes a submerged fissure, cropping out later to a slight extent upon the ventral surface. There is no evidence of a shallow or vadum indicating a separation of the presupersylvian and the supersylvian proper, as sometimes occurs in the fur seal. In Phoca the two fissures are entirely distinct and are without evidence even of a superficial connection. In the walrus the two fissures are continuous with each other, as in the dog and bear, and the differentiation is therefore an arbitrary one.

Perhaps the most puzzling feature regarding the fissures of this specimen of the walrus brain is the relationship of the supersylvian with the postsupersylvian. The conditions appear very much as in the brain of the sea lion (Zalophus). The apparent postsupersylvian is four times as far removed from the sylvian as is the presupersylvian. In this wide area between the sylvian and postsupersylvian Zalophus shows a few minor fissures extending horizontally. In the walrus there are also minor fissures present in this area but also a fairly well-developed fissure nearly vertical in its direction, almost connecting with the supersylvian on the right hemicerebrum, but totally disconnected on the left hemicerebrum. This vertical fissure seems to be too well developed to be classed with the minor fissures and its position and relations suggest the possibility of its being a poorly developed

[a] Fish, The Brain of the Fur Seal (*Callorhinus ursinus*), Report of the Fur Seal Investigation, 1896–97, pt. 3, pp. 21–40.

[b] Anatomischer Anzeiger, V, 1890, pp. 692–709.

and disconnected postsupersylvian fissure. In the cat there is usually a disconnection between the supersylvian and postsupersylvian, and occasionally this disconnection is seen in Callorhinus and Monachus. On the other hand, the vertical fissure is much shallower than the supersylvian, and the latter is continuous with a deep and well-developed fissure apparently corresponding with the postsupersylvian of the sea lion, Phoca, bear, and dog.

The matter is further complicated by the fact that if this be regarded as the postsupersylvian, it is longer than usual, since it passes down from the lateral surface and appears upon the ventral aspect, and lies, in part, in the situation generally occupied by the ectolateral fissure. The ectolateral generally occupies a position between the postsupersylvian and lateral fissures; sometimes it connects with the lateral, but rarely with the postsupersylvian, although such a connection was once observed by me on the hemicerebrum of a young fur seal. The examination of a number of brains shows that the ectolateral is a more variable and inconstant fissure than the postsupersylvian, and in the present specimen of the walrus brain it seems safer to infer that the postsupersylvian and ectolateral have run together to form a long and continuous fissure and that the vertical fissure above mentioned is an unusually well-developed minor fissure. In the sea lion, where this region is so similar to that of the walrus, the postsupersylvian is a shorter fissure and is entirely disconnected from the ectolateral.

The sylvian gyre is that arch-like portion of the cortex around the sylvian fissure included within the boundary line formed by the supersylvian and pre- and post-supersylvian fissures. The cephalic limb of the gyre is narrow and completely submerged in the ventral third of the sylvian fissure. The caudal limb has a much greater area, being easily four times as wide as the cephalic. A few minor fissures branch out from the sylvian into this frontal limb. The caudal limb has a greater number of these fissures, and one in particular is developed to such an extent as to suggest the possibility of its representing the postsupersylvian.

Lateral fissure. This fissure is unequally developed on the two hemicerebrums. The well-defined arch which it forms in some carnivorous and seal brains is not well represented in the walrus. On the left hemicerebrum it is apparently an interrupted fissure; a *pli de passage* or fold of cortex separates it a little in front of the level of the sylvian. From this point on it arches forward and downward. Caudally it does not extend beyond the level of the caudal end of the supersylvian. On the right hemicerebrum, instead of arching in a caudal direction it extends toward and nearly reaches the mesal surface. A short fissure having the direction the lateral should take is separated from the lateral proper by a narrow *pli de passage*. The lateral fissure of the sea lion accords quite closely with that of the walrus, in

that its cephalic portion is much better developed than the caudal. In Ursus, Callorhinus, Phoca, and Monachus, on the other hand, the lateral is the longest fissure of the brain.

Ansate fissure.—No distinct line of separation exists in the walrus between the ansate and the lateral, and the separation into individual fissures is therefore an arbitrary one. A like condition exists in the sea lion, bear, and dog. In Phoca, Callorhinus, Monachus, and the cat some differentiation exists.

Coronal fissure.—In the left hemicerebrum of the walrus there is no line of demarcation between the coronal, ansate, and lateral fissures, and the three together appear as a long, continuous fissure reaching over upon the ventral aspect. On the right hemicerebrum the coronal is an independent fissure, being separated from the ansate by a *pli de passage* or isthmus 6 millimeters in width. On each hemisphere the extent of the coronal upon the ventral aspect is quite remarkable. It reaches nearly to the rhinal fissure just in front of the sylvian. In the bear and sea lion the relation of the coronal, ansate, and lateral fissures is quite similar to that of the walrus.

Supersylvian gyre.—This gyre surrounds the sylvian gyre and is bounded on the one side by the supersylvian and pre- and post-supersylvian fissures; on the other side by the coronal, ansate, and lateral fissures, and caudo-ventrally by a fissure which corresponds, in position, to the medilateral fissure. The frontal and dorsal portions of this gyre are well developed, averaging 30 millimeters in width. Numerous minor fissures, having a direction, in general, perpendicular to the boundary fissures, break up the supersylvian gyre into a number of secondary gyres. The caudal limb of the supersylvian tapers until it reaches a width of only about 20 millimeters, this condition probably being due to the extraordinary width (40 millimeters) of the sylvian gyre in this region.

Ectolateral fissure.—This fissure has already been discussed in connection with the postsupersylvian fissure. In the allied forms studied the ectolateral may or may not extend over to the ventral surface of the brain. It may or may not connect either with the lateral or postsupersylvian, or lie between the two fissures. The fact that the postsupersylvian does not as a rule reach to any extent upon the ventral aspect makes it seem probable that if the ectolateral is at all represented upon the walrus brain it has fused with the postsupersylvian. On the left hemicerebrum it reaches nearly to the postrhinal fissure. On the right hemicerebrum it is shorter and a minor fissure intervenes.

Medilateral fissure.—In some forms the name is particularly appropriate if it has any connection with the relation of the fissure to the median and lateral aspects of the hemicerebrum. Its situation is never very far from the edge or margin separating these two aspects.

In some cases it lies exactly along this margin (Monachus); in other cases it lies partly upon the lateral and partly upon the mesal surface (Callorhinus), or, as in Zalophus, it may be better seen upon the mesal aspect. In the walrus it is better seen upon the lateral aspect. On the left hemicerebrum it arches forward to the vertex, but does not quite reach the mesal margin. At this point another fissure 55 millimeters in length continues forward from the mesal margin in the same direction that the medilateral would take if it were longer. The inference is that it is properly a portion of the medilateral cut off by a narrow isthmus of the cortex.

Another fissure, 70 millimeters in length, separated (from the fissure just described) by an isthmus 13 millimeters, continues forward and downward upon the mesal aspect as far as the cruciate fissure, and has a slight superficial connection with it. The appearances indicate that the medilateral on the left hemicerebrum is divided into three portions—the caudal portion, 90 millimeters long, located on the lateral surface; the middle portion, 55 millimeters, lying in the margin between the mesal and lateral surfaces; and the cephalic portion, 70 millimeters long, lying entirely upon the mesal aspect. On the right hemicerebrum the medilateral lies upon the dorso-lateral aspect and begins far down on the caudal portion of the hemicerebrum, arching upward and forward as far as the vertex. It lies very close to the meso-lateral margin but recedes from it gradually until the vertex is reached. It is interrupted at this point by a cortical isthmus 5 millimeters wide. The cephalic portion of the fissure begins a little mesal to the termination of the caudal portion. As it arches forward and downward it recedes from the mesal margin and extends to a point a little beyond the cruciate. Turner[a] figures the medilateral upon the lateral aspect of both hemicerebrums of the walrus as a long uninterrupted fissure, quite close to the mesal margin caudally but receding from it as it arches downward and forward. In my specimen the medilateral is divided into two portions on the right hemicerebrum, both lying on the dorsolateral surface. On the left hemicerebrum it is divided into three portions and the frontal portion lies upon the mesal surface. If it were a continuous fissure it would be by far the longest fissure of the brain.

Cruciate fissure. This fissure just cuts through the mesal margin and extends only 12 millimeters upon the frontal portion of the lateral surface. On the left hemicerebrum there is a postcruciate fissure, triradiate in form, represented. The precruciate is not well represented except by a short fissure lying in the mesal margin, which fuses into the cruciate. On the right hemicerebrum the postcruciate is not represented as a distinct fissure. It may have become fused

[a] Report on the seals collected during the voyage of H. M. S. *Challenger*, in the years 1873–1876, Zoology, XXVI, 1888, pp. 89–134.

with the medilateral, which at this point has a superficial connection with the cruciate. There is no distinct evidence of a precruciate upon this hemicerebrum. On this account there is no area that may be correlated in any way with the "Ursine Lozenge" thought by Mivart to be of considerable importance in showing a relationship between the seals and the carnivora. In the walrus the cruciate area is quite similar to that of Phoca. In Monachus a slight or rudimentary "Ursine Lozenge" may be detected. In Ursus, Callorhinus, and Zalophus the "lozenge" is well developed. The sigmoid gyre surrounds the frontal portion of the cruciate fissure.

Superorbital fissure. This fissure occupies the usual position upon the ventro-lateral surface of the frontal portion of the brain. On the left hemicerebrum it is about 50 millimeters in length. It arises near the rhinal fissure not far from the base of the olfactory peduncle. It curves laterally and then back again toward the mesal aspect so that its termination is covered by the olfactory bulb. At the lower third of its course it gives off a short and very superficial lateral branch. On the right hemicerebrum the fissure is very similar to that on the left, except that the lateral branch is much smaller.

Lateral gyre (Mediolateral convolution of Turner). In the present specimen this gyre is not well represented upon the caudal portion of the brain. The short length of the lateral fissure brings about the unusual condition of having the mediolateral fissure form a portion of the boundary of the supersylvian gyre. In this case, therefore, the medilateral gyre begins well up toward the vertex in a tapering manner and gradually becomes wider as it arches toward the frontal portion of the brain, attaining a width of from 30 to 40 millimeters in its widest parts. Like the supersylvian gyre, it contains a number of minor fissures.

Marginal or sagittal gyre.—On the left hemicerebrum this is a very narrow gyre and is represented only on the caudal portion. It disappears at the vertex. This disappearance is due to the fact that the frontal portion of the interrupted medilateral fissure lies upon the mesal aspect. Two or three traces of minor fissures appear in the left saggittal gyre. On the right hemicerebrum the gyre has a fair width in its caudal portion, but becomes narrower, until at the vertex it almost disappears, but it gradually widens again until in the frontal portion it attains the width of 17 millimeters. On this hemicerebrum there are a number of quite well-developed minor fissures present, which in almost every instance extend over upon the mesal surface.

Pre and post sylvian areas.—The post sylvian region comprises the unusually wide caudal limb of the sylvian gyre, the supersylvian gyre, and the narrow marginal (or sagittal) gyre. The presylvian region includes the very narrow frontal limb of the sylvian gyre, and the wide frontal limbs of the supersylvian and medilateral gyres. On the

right hemicerebrum the marginal gyre should be included. The presylvian has a greater area than the postsylvian region. The former is made up mostly of the medilateral and supersylvian gyres and the latter by the sylvian and supersylvian gyres.

MESAL ASPECT.

Hippocampal fissure.—This occupies the usual position. It is seen arching from the splenium of the callosum around the optic thalamus to the tip of the pyriform or temporal lobe.

Callosal fissure.—As its name indicates, it is closely related to the callosum. It separates the callosum from the adjacent cortex. It is deepest in the region of the splenium and gradually grows shallower until as it curves around the genu it becomes flush with the surface. On the right hemicerebrum it diverges somewhat from the genu of the callosum.

Splenial fissure.—This fissure is well developed in the walrus and occupies the usual position upon the tentorial surface of the brain. It arches upward and forward, curving around the splenium on the mesal surface. On the right hemicerebrum it is a continuous fissure and extends as far as the frontal portion of the callosum; it then extends upward almost vertically nearly to the dorsal margin of the hemicerebrum. On the left hemicerebrum the fissure is interrupted. Its tentorial portion stops at the level of the splenium. The mesal portion begins as two small superficial fissures converging in a fork-like manner to form the mesal splenial proper. At the level of the genu it terminates in a fork, the lower branch passing nearly to the frontal margin of the hemicerebrum. In neither case did the splenial connect with the cruciate, as described by Turner in his specimens. On the right hemicerebrum there was a slight indication of a superficial connection, but a submerged gyre or buttress shut off any free communication.

Hippocampal gyre.—This gyre lies upon the tentorial surface of the brain. It forms the most of the mesal portion of the pyriform or hippocampal lobe. It takes the same general direction as the hippocampal fissure (which forms its cephalic or inner boundary), arching upward to the level of the splenium. Its caudal boundary is formed by the tentorial portion of the splenial fissure. The hippocampal gyre averages 15 millimeters in width and possesses a few minor fissures, which in the main are offshoots from the splenial and have a horizontal direction. On the left hemicerebrum, lying in the hippocampal gyre just caudal to the splenium, is a very shallow sulcus corresponding in position to the fissura sublimica of Kükenthal. It is not noticeable upon the right hemicerebrum.

Callosal gyre.—This, as the name indicates, lies just dorsal to the callosum. It is a narrow gyre and its average width is about 10 milli-

meters. Only one or two faint traces of minor fissures are evident. It is the simplest gyre of the brain and is continuous with the hippocampal gyre around the splenium of the callosum.

Presplenial fissure.—This fissure is not well represented on either hemicerebrum of the walrus. On the right hemicerebrum a shallow and short vertical fissure may indicate it. On the left hemicerebrum the only representative of it would be the upper branch of the frontal portion of the splenial. Neither Turner nor Ziehen figures or describes its presence. The fissura sublimica anterior is not shown at all unless, as in Kükenthal's diagram, it is confused with the cruciate.

Postsplenial fissure.—In Phoca and Callorhinus the tentorial portion of the splenial terminates in a bifurcation, the caudal horizontal branch of which is called the post splenial. This is not the case in my specimen of the walrus brain. Respecting this region in the walrus, Turner says:

Behind and below the end of the specimen the splenial fissure gave off a postero-horizontal fissure, which, running horizontally backward, extended almost to the posterior border of the hemisphere. * * * The post-splenial fissure of Krueg was situated behind the ascending part of the splenial fissure and ran backward and upward nearly to the posterior border of the hemisphere below the postero-horizontal fissure. It was separated from the splenial fissure by the splenial convolution, which is consequently bounded in front by the splenial and behind by the post-splenial fissure.

On the left hemicerebrum of my specimen there is a small fissure 15 millimeters in length which corresponds in position to the postero-horizontal of Turner. On the right hemicerebrum a mere spur 5 millimeters long from the splenial represents it.

With regard to the post splenial there is found on the right hemicerebrum a well-developed vertical fissure branching out of the splenial not far from its tentorial origin. This I regard as the post-splenial fissure, although its direction is vertical and not horizontal. On the left hemicerebrum there is no connection between the splenial and what I regard as the post splenial. The fissure is not so well developed as that described by Turner, unless in my specimen it is an interrupted fissure. An unnamed but well-developed fissure extending dorsally is separated from what I consider the post splenial by a cortical isthmus of only 4 millimeters' width. The appearances suggest an interrupted fissure. Turner does not describe any connection between the post-splenial and splenial fissures, but calls the intervening space the splenial convolution (gyre).

Marginal fissure.—In Zalophus, Phoca, and Callorhinus this is a well-developed fissure lying between, and approximately parallel with, the splenial and medilateral fissures. It seems to correspond in many cases with the suprasplenial fissure of Krueg, and in some special cases with the combined post and supra splenial of the same author. In the walrus the marginal is not especially well developed. On both

hemicerebrums there is a fair-sized fissure occupying the proper location. The appearances are very suggestive of those in Monachus, where the fissure is relatively short and undeveloped and sometimes appears interrupted. On the left hemicerebrum where the splenial is interrupted there is a fissure dorsal to, and running parallel with, the callosal portion of the splenial. From its position the name suprasplenial would be very appropriate, although in some respects it differs from Krueg's. On the right hemicerebrum it is not represented.

Marginal gyre.—This, in general, refers to the cortical area lying between the splenial and medilateral fissures, and would therefore include, in the walrus, the dorsal margin of the hemicerebrum, on account of the extended development of the medilateral fissure. What I have described as the marginal fissure lies within this gyre, and the name therefore seems appropriate.

Collateral fissure.—This fissure appears upon the tentorial surface, and is perhaps best seen on the ventral or mesal aspect. Its form is somewhat arched, and it lies ventrally to the origin of the splenial. It begins not far from the hippocampal, and its termination caudally is usually more or less closely associated with either the lateral or medilateral fissure, so that in some cases, at least, it may appear upon the ventro-lateral aspect of the hemicerebrum.

Genual fissure.—This is commonly a shallow fissure, lying in front of and is more or less closely associated with the genu of the callosum, from which fact it takes its name. It is found in both hemicerebrums of the walrus. On the left it has a short frontal branch which connects superficially with an unnamed minor fissure. On the right hemicerebrum it is farther removed from the genu, and ventrally it fuses with the rostral fissure.

Rostral fissure.—This is also a shallow fissure and lies nearer to the frontal margin of the hemicerebrum. On the left it is a straight fissure 30 millimeters long. On the right hemicerebrum it is of the same length, and its dorsal end reaches the margin. On account of the convergence of the rostral and genual fissures the basal or ventral third represents a combination of these two fissures.

The lateral ventricle (paracoele).—On removing the dorsal portion of the hemicerebrum just dorsal to the callosum the lateral ventricle is revealed. The cavity dips cephalo-ventrad, ending blindly, to form the precornu; it also dips caudo-latero-ventrad to form the medicornu. The striatum (caudate nucleus) is a convex and well-defined body forming the most of the floor and lateral side of the precornu. Parallel with the oblique caudal margin of the striatum is the fimbrial margin of the hippocamp, which, extending down into the medicornu, forms with the hippocamp the floor of this cavity. Between these two margins (striatum and fimbria)—the rima (great transverse fissure), the choroid (para) plexus—a continuation of the velum enters the floor of the medicornu. The rima is narrow and the thalamus does not

appear at all in the floor of the ventricle. A slight caudal projection of the cavity, at the beginning of the medicornu, extending just beyond the level of the splenial fissure, represents the postcornu. In his dissection of the walrus brain, Turner shows no indication of a postcornu, but in the text he states: "Where the cavity of the ventricle curved downward and outward into the horn, an indication of a recess was seen in its posterior horn, but it did not amount to a cornu and there was no elevation which could be called a hippocampus minor." In Ursus there is no postcornu. In Callorhinus a slight caudal spur of the cavity indicates its position. Zalophus was not examined in this region. In Monachus there is a fairly well-developed postcornu. Murie describes a well-developed postcornu in the Manatee and Otaria, and in both a well-developed hippocampus minor or calcar. In *Phoca vitulina* the postcornu is relatively large, and the hippocampus minor is well developed, being correlated with the splenial fissure and making of it, for a portion of its course at least, a total fissure.

Terminology.—A difficulty of some importance is the selection of the terms to be employed in the description of the fissures and gyres, particularly in the brain of the Pinnipedia, where the literature is not especially abundant. The literature on the carnivorous brain is more extensive, but as many authors have employed terms of their own without reference to the nomenclature used by others, some confusion has naturally resulted. It has therefore seemed best in the present case not to follow the terminology of any one author, but to use those terms which, by their special fitness, seemed most appropriate. On this account the priority of terms has not been especially considered, for in some cases later investigations have shown that some of the earlier terms were not the best to use in considering the homologies between the various forms.

Some of the more common synonyms of the names of the various fissures used in this article are as follows: The supersylvian is very commonly called the suprasylvian. Turner and Gratiolet have apparently confused this fissure with the lateral in Phoca. I have preferred the term postsupersylvian, as used by Krueg, Turner, and others, to postsylvian, as recommended by Owen and Wilder. The term presupersylvian has been introduced to apply to what is commonly described as the anterior or frontal portion of the supersylvian or the ectosylvia antica of Ziehen. The superorbital of Flower and Wilder is preferred to the intraorbital of Turner and Langley. This fissure has also been designated as the presylvian by Krueg and others. The term presylvian has also been applied by some writers to describe what commonly appears to be the coronal fissure. Cruciate is retained, as is done by most writers, although frontal fissure is the term originally suggested by Owen. I have also employed the term marginal fissure, as used by Owen and Wilder, instead of suprasplenial, as used by Krueg and Turner.

SUMMARY.

After obliterating the numerous minor fissures and the branches of the principal fissures from the cerebrum of the walrus there is left a very good fissural pattern resembling, in general, the typical arrangement of the fissures in the brain of carnivorous animals. As in the cat, dog, and bear, the presylvian area is greater in length than the postsylvian. In the sea lion the two areas are about equal. In Monachus, Callorhinus, and Phoca the postsylvian area is longer than the presylvian.

The epiphysis is very highly developed in the walrus, and in the seals it is much better developed than in carnivora. The olfactory bulbs and peduncles resemble those of the seals and do not attain as relatively great development as in carnivora. The postrhinal resembles the conditions in Zalophus, Callorhinus, and Monachus. The fissure postica resembles that of Ursus, Zalophus, Callorhinus, and Phoca. The supersylvian resembles that of the dog and bear. The postsupersylvian is correlated more closely with that of Zalophus than in any of the other forms studied. The ectolateral, by fusing with the postsuperylvian, differs from any of the other forms. The lateral fissure corresponds with Zalophus in that it is relatively short. The ansate fissure resembles the condition found in Zalophus, Ursus, and Canis. The coronal is quite similar to that in Ursus and Zalophus. The medilateral differs from that of the other forms in that it is interrupted; if considered as a continuous fissure it would be the longest fissure of the brain. The cruciate resembles the conditions found in Phoca and Monachus. The splenial accords more closely with the conditions found in Zalophus and Monachus. The marginal fissure resembles that of Monachus; it is not especially well developed. The development of the postcornu suggests a condition between that found in Callorhinus on the one hand and Monachus on the other.

As a matter of convenience, a table of the more important regions in the representatives of the different groups examined is herewith appended:

No.	Region.	Ursus.	Callorhinus.	Zalophus.	Rosmarus.	Monachus.	Phoca.
1	Subfissure postica (?).	Present.....	Present.....	Present.....	Present.....	Not very distinct.	Present.
2	Postrhinal..	Continuation of rhinal, exceptionally postica.	Connects with postica.	Connects with postica.	Connects with postica.	Mere trace, very superficial, connection with postica.	Continuation of rhinal.
3	Presupersylvian.	Continuous with supersylvian.	Sometimes disconnected.	Continuous.	Continuous.	Continuous.	Disconnected.
4	Postsupersylvian.	Continuous with supersylvian.	May or may not be continuous.	Continuous.	Continuous.	May or may not be continuous.	Usually continuous.

No.	Region.	Ursus.	Callorhinus.	Zalophus.	Rosmarus.	Monachus.	Phoca.
5	Precruciate.	Mostly dorsal.	Dorsal	Dorsal	Presence doubtful.	Mesal and dorsal.	Not clearly shown.
6	Cruciate	Dorsal	Dorsal	Dorsal	Mesal and dorsal.	Mesal and dorsal.	Mesal and dorsal.
7	Postcruciate	Present	Present	Present	Sometimes not distinct.	Rudimentary.	Present.
8	Medilateral.	Present	Present	Present	Long and disconnected.	Present	A series of small disconnected fissures.
9	Marginal	Absent	Present	Present	Present	Short, interrupted fissures.	Present.
10	Collateral	Absent	Present	Rudimentary.	Present	Present	Present.
11	Minor fissures.	Rare	Quite numerous	Not many	Numerous	Quite numerous.	Quite numerous.
12	"Ursine Lozenge."	Present	Present	Present	Not distinct.	Small	Absent.
13	Postcornu	Absent	Rudimentary.	(?)	Small	Fair size	Large.
14	Calcar. (Hippocampus minor.)	Absent	Absent	(?)	Absent	Indistinct	Very distinct.
15	Insula	Slight	Slight	Slight	Slight	Slight	Slight.
16	Pre and post sylvian areas.	Presylvian area longer.	Postsylvian longer.	The two areas approximately equal.	Presylvian area longer.	Postsylvian longer.	Postsylvian longer.

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For a more complete bibliography of literature pertaining to the brain of the Carnivora and Pinnipedia, consult the work of Flatau and Jacobsohn or Turner's *Challenger* Report.

EXPLANATION OF PLATES.

ans.	= Ansate fissure.
cal.	= Callosum.
c. g.	= Callosal gyre.
cl.	= Callosal fissure.
col.	= Collateral fissure.
cor.	= Coronal fissure.
cr.	= Cruciate fissure.
el.	= Ectolateral fissure.
g.	= Genual fissure.
h.	= Hippocampal fissure.
h. g.	= Hippocampal gyre.
l.	= Lateral fissure.
l. g.	= Lateral gyre.
marg.	= Marginal fissure.
m. g.	= Marginal gyre.
ml.	= Medilateral fissure.
pcr	= Postcruciate fissure.
ph.	= Postero-horizontal fissure.
prspl.	= Presplenial fissure.
prss.	= Presupersylvian fissure.
pspl.	= Postsplenial fissure.
pss.	= Postsupersylvian fissure.
r.	= Rostral fissure.
so.	= Superorbital fissure.
spl.	= Splenial fissure.
syl.	= Sylvian fissure.
ss.	= Supersylvian fissure.
syl. g.	= Sylvian gyre.
ss. g.	= Supersylvian gyre.

Plate XXVIII.

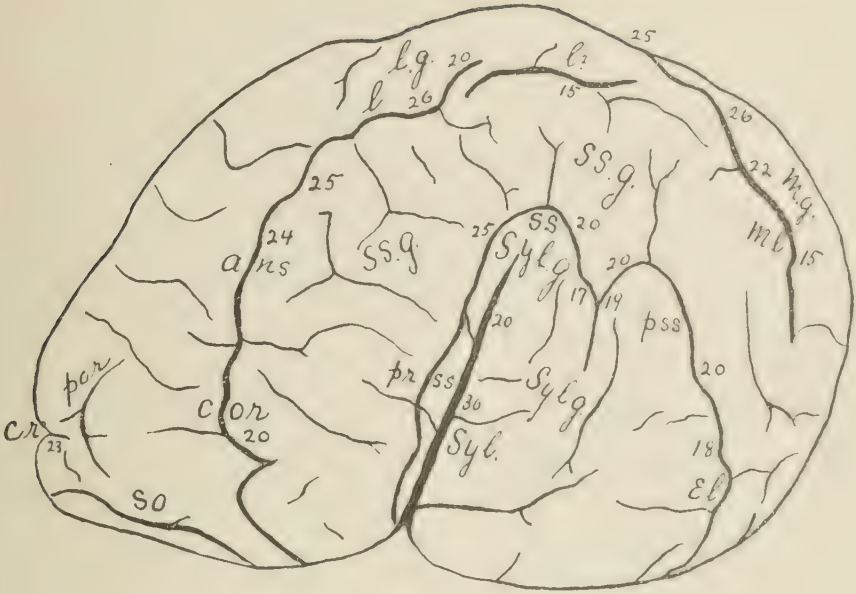
Fig. 1. Lateral aspect of the left hemicerebrum of *Rosmarus rosmarus*. The various fissures were sounded and the numbers represent the depth in millimeters of the fissure at that point.

Fig. 2. Lateral aspect of the right hemicerebrum of *Rosmarus rosmarus*. The numbers represent the sounding of the fissures as in fig. 1.

Plate XXIX.

Fig. 3. Mesal aspect of the left hemicerebrum of *Rosmarus rosmarus*.

Fig. 4. Mesal aspect of the right hemicerebrum of *Rosmarus rosmarus*.



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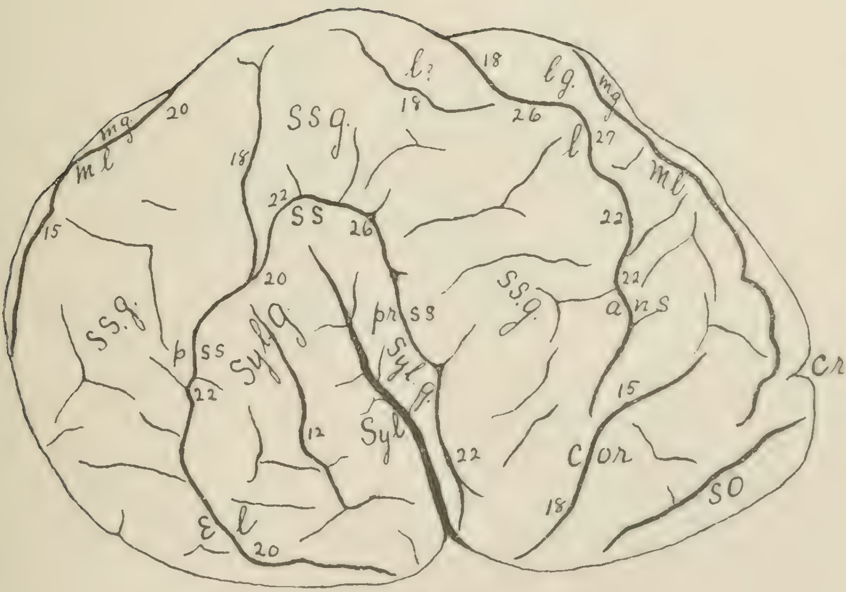
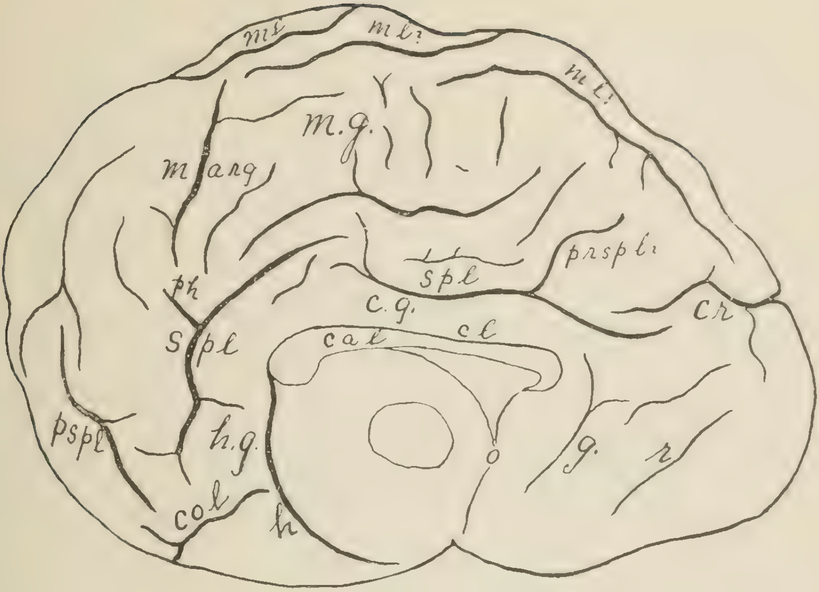


2

LATERAL ASPECT OF BRAIN OF WALRUS.

FOR EXPLANATION OF PLATE SEE PAGE 688.



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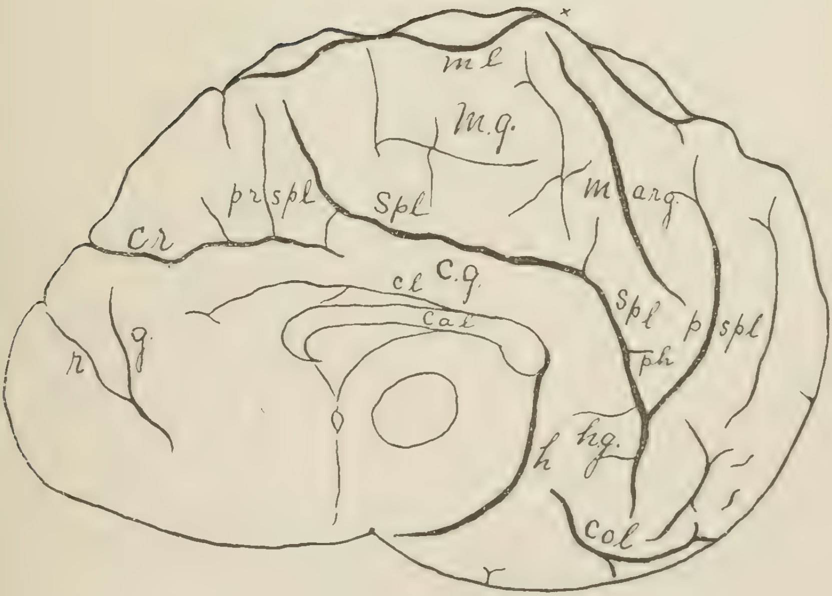


2

MESAL ASPECT OF BRAIN OF WALRUS.

FOR EXPLANATION OF PLATE SEE PAGE 688.

DESCRIPTION OF A NEW SPECIES OF SCULPIN FROM JAPAN.

By David Starr Jordan and Edwin Chapin Starks,
Of the Leland Stanford Junior University.

In the present paper is given a description of a new species of Sculpin belonging to the genus *Cottunculus*, dredged by the U. S. Fish Commission steamer *Albatross* in Japan.

COTTUNCULUS BREPHOCEPHALUS Jordan and Starks, new species.

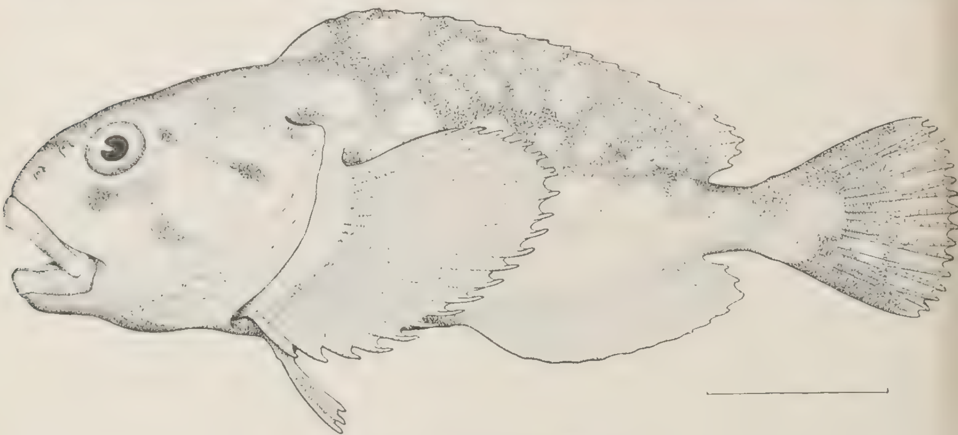
Head $2\frac{1}{3}$ in length without caudal; depth $3\frac{1}{4}$. Dorsal VI 16; anal 12. Eye $4\frac{1}{2}$ in head; maxillary $2\frac{1}{3}$.

Head considerably wider than deep, flat on top; the nape somewhat produced, the rostral region evenly rounded; jaws equal or the lower very slightly included; maxillary reaching to below middle of eye; rather sharp villiform teeth in moderate bands on jaws and vomer; the bands of equal width on premaxillaries and mandible, wider in front than at sides; vomerine patches small, narrower than those on jaws, and having a wider interval between than that between premaxillary bands. Interorbital space wide and flat; between iris $2\frac{1}{4}$ in head, the bone only half as wide. Nostrils ending in short tubes, the anterior separated from the posterior a distance equal to half the length of eye. Head without spines; a pair of very slight tubercles may be felt between eyes and one on upper part of preopercle, but the occipital, the suborbital, the preopercle, and the other spines as possessed by *Cottunculus microps* and *C. thompsoni* are entirely absent.

Origin of dorsal directly above upper end of gill-opening, the length of the fourth spine $4\frac{1}{2}$ in head, the rays toward the posterior end the longest, $2\frac{1}{5}$ in head, the tips of the last rays, when fin is depressed, reach to the rudimentary caudal rays, or slightly beyond the tips of anal rays. Origin of anal midway between tip of lower jaw and anterior third of caudal rays, its posterior or longest rays a little shorter than those of dorsal. Pectoral reaching to above base of fourth

anal ray, its upper 6 rays branched, its lower (14) rays simple. Length of ventrals $2\frac{3}{4}$ in head. Caudal truncate, rounded at its outer corners. Skin entirely smooth.

Color in spirits: Back and dorsal dusky, with fine blackish points surrounding light spots; under parts and lower fins without color, probably pinkish or red in life; a row of 6 or 7 large light spots along side from opercle flap to base of middle caudal rays; light clouded



Cottunculus brephocephalus.

areas above and on dorsal; a dusky band extending downward and backward from eye, and some dusky, irregular spots on opercle; top of head colorless; caudal crossed by a broad band of dusky, the tip colorless. Peritoneum black; inside of gill-covers white.

This species may be known by the absence of blunt spines and by the coloration.

The type was dredged by the U. S. Fish Commision steamer *Albatross* in Suruga Bay in 94 fathoms, Station 3704. It is 13 cm. in length, and bears the number 50591, U.S.N.M.

ON THE IDENTIFICATION OF A SPECIES OF EUCALYPTUS FROM THE PHILIPPINES.

By Joseph Henry Maiden,

Government Botanist of New South Wales and Director of the Botanic Gardens, Sydney.

In the Botany of the United States Exploring Expedition during the years 1838–1842, under the command of Charles Wilkes, U. S. Navy,[a] there is given[b] an account of a plant found near Caldera, Mindanao, one of the Philippine Islands. Leaves and fruits were available, and Asa Gray says, "I thus record the plant under the name *Eucalyptus multiflora* Rich, given by Mr. Rich[c] in the collection."

Bentham refers[d] to this specimen in the following words:

> A fifth species of Eucalyptus from a still more distant region, Mindanao, one of the Philippine Islands, is described by A. Gray in the Botany of the American Exploring Expedition,[e] under the name of *E. multiflora* Rich, from a specimen in leaf, and with a panicle of old fruits from which the calyx limb and operculum, if any, are fallen away and the open capsules have lost all their seeds. The four-celled (not three-celled) capsule is the only character leading us to suppose that it may be a Eucalyptus rather than a Tristania or a Metrosideros. No mention of it occurs in Blanco's Flora.

It will thus be seen that the very identity of the genus of this plant was doubted by an eminent authority.

A short time ago, through the kindness of the Secretary of the Smithsonian Institution, Washington, D. C., I was able to examine Gray's specimen. It is No. 25483 of the U. S. National Herbarium, and as it turns out to be identical with *Eucalyptus naudiniana* F. v. Müller, *E. multiflora* Rich, must fall because the name is preoccupied (*E. multiflora* Poiret, probably a synonym of *E. pilularis* Smith).[f]

[a] Phanerogamia by Asa Gray, I, 1854.

[b] Page 554.

[c] William Rich, botanist of the U. S. ship *Relief*. In Captain Wilkes' narrative Mr. Rich's name is given as one who made an excursion from Manila, and he speaks of "our botanical gentlemen botanizing in the forests of Mindanao."

[d] Journ. Linn. Soc. (Botany), X, p. 143.

[e] Page 554.

[f] See DC. Prod., III, p. 217, under *E. persicifolia* Lodd.

There are so few Eucalypti found outside Australia that the questior of the identity of one found beyond the limits of that continent is of interest, and the occurrence of the genus in the Philippines is now set at rest and doubtless its range in that group will be ascertained by American botanists.

E. naudiniana F. v. Müller is so little known that the following notes in regard to it may be acceptable. It was described by Müller in the Australasian Journal of Pharmacy,[a] under the title of Description of a hitherto unrecorded species of Eucalyptus from New Britain. New Britain is of course now a German possession under the name of Bismarck Archipelago.

A correspondent in that group writes to me:

> *Eucalyptus naudiniana* is common in New Pommern, though not in the Ralun district, where I live. It grows especially on the rivers, from the coast to the moun tains, and is so common in the forests that two sawmills have been started especiall for this timber. The timber is not so hard as the Australian Eucalyptus but still good, useful timber.

I know of no locality for the species other than that indicated in thi paper.

[a] July, 1886.

SUPPLEMENTARY NOTE ON BLEEKERIA MITSUKURII, AND ON CERTAIN JAPANESE FISHES.

By David Starr Jordan,

President of the Leland Stanford Junior University.

In the present paper are given a few notes supplementary to different papers on Japanese fishes recently published in these Proceedings.

EMBOLICHTHYS MITSUKURII (Jordan and Evermann).

In Notes on a Collection of Fishes from the island of Formosa, in these proceedings,[a] Jordan and Evermann have described a new species of Ammodytoid fish from Giran, Formosa, under the name of *Bleekeria mitsukurii*. This species differs from the type of Bleekeria in having ventral fins. These are small, jugular in position, and composed of a short spine and three slender rays. There are 115 scales in a horizontal series. The presence of ventrals may define a distinct genus, *Embolichthys* Jordan and Evermann, of which *Bleekeria mitsukurii* is the type. The presence in this species of jugular ventral fins with the rays fewer than I, 5, shows that the *Ammodytidæ* have no affinity with the Percesoces, nor with the extinct family of *Cobitopsidæ*. Their place must be near the *Ophidiidæ*, as supposed by earlier and some recent writers.

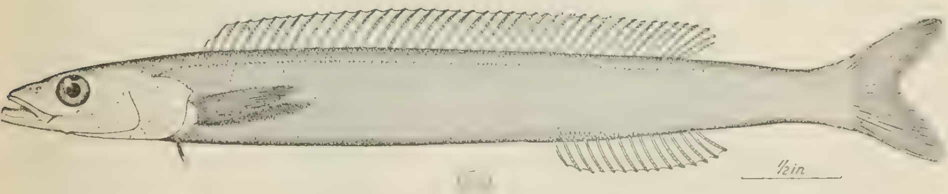


Fig. 1.—Embolichthys mitsukurii.

[a] Proc. U. S. Nat. Mus., XXV, 1902, p. 333.

ZEN ITEA (Jordan and Fowler).

In the review of the *Chætodontidæ* and related families of fishes found in the waters of Japan by Messrs. Jordan and Fowler,[a] a new species of *Zeida* is described from Suruga Bay, Japan, under the name of *Cyttopsis itea*. This species differs from the type of *Cyttopsis* (*rosea*)

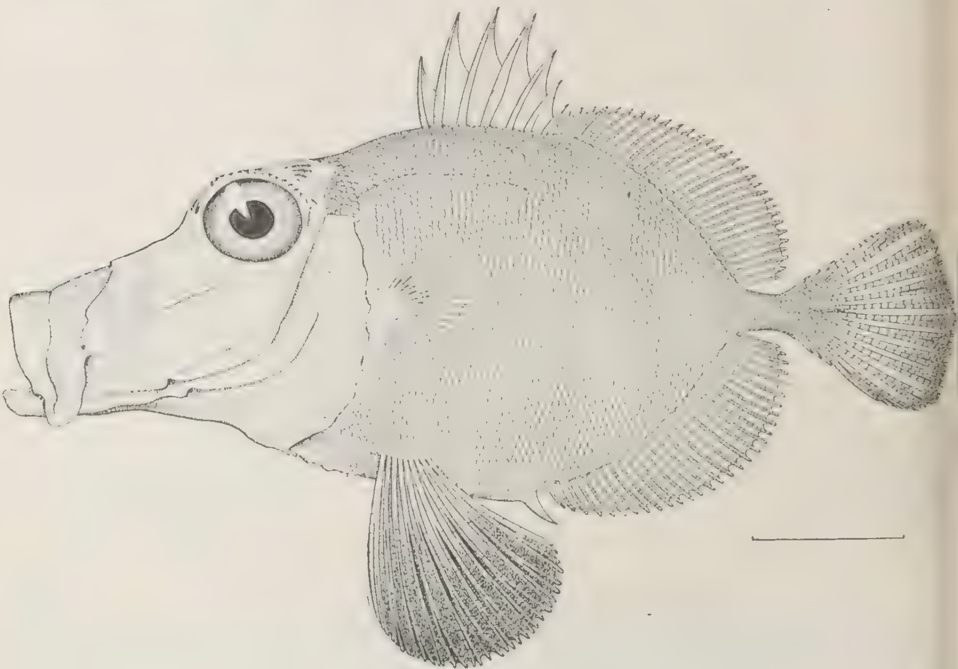


FIG. 2.—ZEN ITEA.

in having the ventral rays I, 9, and in having the breast flat and broad, imperfectly shielded. This is the type of a new genus, *Zen* Jordan, the species standing as *Zen itea*.

HENIOCHUS DIPHREUTES.

In the same paper[b] a Japanese fish from Wakanoura and Nagasaki is described under the name of *Heniochus macrolepidotus*. From this well known East Indian species, the Japanese form differs in having the posterior black band from soft dorsal to anal not extending forward to cover the anterior part of the anal fin. It seems to be a distinct species, which may receive the name of *Heniochus diphreutes* Jordan. The type is No. 7247, Ichthyological Collections, Stanford University. The description of *Heniochus macrolepidotus* Jordan and Fowler[b] applies to this species. The accounts given by Schlegel[c] and

[a] Proc. U. S. Nat. Mus., XXV, 1902, p. 519.
[b] Idem, p. 542.
[c] Fauna Japonica, Poiss., 1846, p. 82, pl. XLIV, fig. 1.

by Steindachner,[a] refer also to *Heniochus diphreutes*. Schlegel's specimens, like ours, came from Nagasaki; Steindachner's came from Kochi, in Shikoku. *Heniochus macrolepidotus* has not been taken in Japan.

The plate here given is drawn by Kako Morita.

FIG. 3.—HENIOCHUS DIPHREUTES.

TEUTHIS DUSSUMIERI.

The specimens of *Teuthis* recorded from Nafa, Umesawa, and Misaki,[b] under the name of *Teuthis argenteus*, seem to belong to *Teuthis dussumieri* (Cuvier and Valenciennes). There are several Polynesian species closely related to this, and their synonymy is much complicated. The larval specimens from Hawaii, named *Acanthurus argenteus* by Quoy and Gaimard, may have belonged to any one of half a dozen species, although most resembling *Teuthis dussumieri*. We have just such specimens from Hilo, and as we can not positively identify them

[a] Fische Japans, II, 1883, p. 24.
[b] Proc. U. S. Nat. Mus., XXV, 1902, p. 553.

with one species rather than another, it is probable that *argenteus* should not be used for any species of *Teuthis.*

CHASMICHTHYS GULOSUS (Guichenot).

The species of Goby described by Jordan and Snyder as *Chasmias misakius*[a] was earlier named *Saccostoma gulosum* by Sauvage.[b] It was then made the type of the genus *Saccostoma.* This name, as well as the first name suggested by us, *Chasmias*, is preoccupied, and the genus must retain the still later substitute name of *Chasmichthys.* The known species of the genus are *Chasmichthys gulosus* (*misakius*) and *Chasmichthys dolichognathus.*

[a] Proc. U. S. Nat. Mus., XXIII, 1901, p. 761.

[b] Guichenot MS., Bull. Soc. Philom., VI, 1882, p. 171; Japan.

CHASMICHTHYS GULOSUS (MISAKIUS).

FOR EXPLANATION OF PLATE SEE PAGE 696.

THE USE OF THE NAME TORPEDO FOR THE ELECTRIC CATFISH.

By Theodore Gill,
Honorary Associate in Zoology.

In the Proceedings of the U. S. National Museum for 1895 (p. 161) the name Torpedo was revived for the electric catfish, generally known as *Malapterurus electricus.* This view has been adopted by several authors (Jordan, Evermann, etc.) and doubtless will be generally by those who adhere strictly to rules of priority. It has already been indicated that the application of the name to the electric rays by the ancients was secondary and not primary, and that the term was as applicable to the electric catfish as to the electric rays. I was not aware, however, that it had been so applied by any other than Forskal. Recently my attention was accidentally drawn to the fact that in 1843 Heckel had indicated that the catfish was mentioned under the name Torpedo by Athenæus and Purchas.

I have searched in vain in the Deipnosophistæ of Athenæus for any mention of the Torpedo or νάρκη which could be referred to the electrical catfish. All the notices found (VII, c. 95; VII, c. 120; VII, c. 140) relate to a sea fish, avowedly or in all probability. In an imperfect list of "the chief fish found in the Nile" (VII, c. 92), only sixteen[a] species are named, but it is remarked that "there are also a great number of others." Unfortunately Heckel has given no reference to the chapter of Athenæus which led him to suppose that reference to the catfish was meant; his only citation (in the Abbildungen und Beschreibungen der Fische Syriens) under "Athenæus" is in a chronological summary of authors treating of Egyptian fishes, where, in a list of sixteen species (p. 218), the following reference is made: "Torpedo. Malapterurus electricus *Lacep.??*" In the systematic list of species, under *Malapterurus electricus* (p. 230), "Torpedo *Athenæus?*" is also named.

[a] This list is exclusive of species which Athenæus had just before mentioned in the same chapter, that is, the *Latos*, different *Coracini*, and the *Mæotæ*. Incidentally, it may be added that Athenæus says that the *Latos* "is like the fish called the *Glanis*, which is found in the Danube"! The *Coracini* doubtless included the celebrated Bolti (*Tilapia nilotica*).

In Purchas His Pilgrimes, published in 1625, two notices of the electric catfish or Raad of the Nile appear.

In the seventh booke Abyssinia, called then Abassia, is described, and a notice of Abassine animals is given (p. 1183).

In thefe Riuers and Lakes is alfo found the Torpedo, which if any man hold in his hand, if it ftirre not, it doth produce no effect: but if it moue it felfe neuer fo little, it fo tormenteth the body of him which holds it, that his Arteries, Joints, Sinewes, & all his Members feele exceeding paine with a certaine numbneffe; and as foone as it is let go out of the hand, all that paine and numbneffe is alfo gone. The Superftitions *Abaffines* beleeue that it is good to expell Deuils out of humane bodies, as if it did torment Spirits no leffe than men. They fay, if one of thefe aliue bee laid amongft dead Fifhes, if it there ftirre it felfe, it makes thofe which it toucheth to ftirre as if they were alive. There is great ftore of this kind in *Nilus*, in the furtheft parts of *Goyama*, where there is a Meere or Fenne without bottome, welling and admirably boyling forth waters continually, whence *Nilus* fpringeth.

In the twelfth booke, in which the present country of Mozambique is described (p. 1545), the Torpedo is named in the margin, and the following notice of it appears:

In the Riuer of *Sofala* is ftore of Fifh fat and sauorie, as Mullets, Needles, Dolphins, &c. One ftrange fifh in qualitie is common in thofe Riuers, which the *Portugals* call *Tremedor*, and the *Cafres*, *Thinta*, of fuch nature that no man can take it in his hand while it is alive, for it filleth the hand and arme with paine, as if every ioint would go afunder; but being dead is as another fifh, and much efteemed for good meate. The Naturals fay, that the skin of this fifh is vfed to forceries. It is medicinable againft the Cholick, rofted and ground to powder and drunke in Wine. The biggeft of them is two fpannes and halfe long, the skin blackifh, rough and thick.

It is quite likely that Forskål may have read these accounts, and thence been influenced in appropriating the name Torpedo as the generic designation of the fish in question.

A REVIEW OF THE CEPOLIDÆ OR BAND-FISHES OF JAPAN.

By DAVID STARR JORDAN and HENRY W. FOWLER.
Of the Leland Stanford Junior University.

In this paper is given a review of the species of Band-fishes or *Cepolidæ* known to inhabit the shores of Japan. The material studied is in the museum of Leland Stanford Junior University and in the United States National Museum. It was chiefly collected by Messrs. Jordan and Snyder during the summer of 1900.

Family CEPOLIDÆ.

BAND-FISHES.

Body very elongate, compressed, band-like, covered with small cycloid scales, lateral line obscure. Head obtuse; cleft of the mouth wide and oblique; teeth moderate on jaws only; eyes large, lateral; gill-openings wide, the membranes not united, free from the isthmus; gills 4; pseudobranchiæ present; branchiostegals 6; air-bladder large; pyloric cœca few. Skull well ossified. Dorsal and anal fins each very long, composed of slender rays, which are either simple or branched and more or less distinctly articulated; both fins more or less joined to the caudal; ventral fins thoracic, their rays I, 5.

Coasts of tropical Europe and Asia; shore fishes of a deep red color; a peculiar group, having something in common with the *Ophidiidæ*, but with the normal ventrals thoracic, in position of the ordinary percoid fishes. Its relations are perhaps nearer the *Latilidæ* than any other of the better known groups.

a. Preopercle unarmed; dorsal rays more or less distinctly articulate, usually branched. *Cepola*, 1.

aa. Preopercle with 4 to 8 blunt spinous teeth; dorsal rays indistinctly articulated, not branched . . . . *Acanthocepola*, 2.

1. CEPOLA Linnæus.

Cepola LINNÆUS, Syst. Nat., 12th ed., I, 1769, p. 445 (*tænia*).

This genus includes the *Cepolidæ* which have the preopercle unarmed; dorsal rays rather distinctly articulate, and in typical species also distinctly branched.

(*cepola*, a name unexplained, probably of Italian origin.)

1. CEPOLA SCHLEGELI Bleeker.

AKADASHI (RED WEASEL).

Cepola krusensterni SCHLEGEL, Fauna Japonica, Poiss., 1845, pl. LXXI, fig. 1; Nagasaki, not description.—NYSTROM, Svensk, Ak. Handl., 1887, p. 39; Nagasaki.

Cepola schlegeli BLEEKER, Nat. Tijds. Ned. Ind., 1854, Japan, p. 412; Kaminoseki; Verh. Bat. Gen., XXVI, 1854, Japan, p. 110; Act. Soc. Sci. Ind. Neerl., VI, 1859, p. 256.—GÜNTHER, Cat. Fish., III, 1861, p. 488.—STEINDACHNER and DÖDERLEIN, Fische Japans, IV, 1887, p. 12; Tokyo, Kochi, Tango.—ISHIKAWA, Prel. Cat., 1897, p. 32; Bingo.—JORDAN and SNYDER, Check List, Fish, Japan, 1901, p. 111.

Head 10 in length; depth 12; D. more than 70; A. more than 60; P. 18; V. I 5; scales more than 300; eye 3 in head; width of head $1\frac{3}{5}$ in height. Pectoral $1\frac{3}{5}$ to $1\frac{3}{4}$ in head. Body elongate, strongly compressed. Head obtusely convex, longer than high; snout half the length of the eye, profile convex; maxillary reaching below posterior part of eye, oblique; teeth in jaws uniserial, curved and conic; preopercle without spines; opercle a little over 3 in head. Scales very small, present on opercles. Lateral line concurrent with back. Dorsal, anal, and caudal continuous; pectoral rounded.

Color, body and fins rosy; the membrane between premaxillary and maxillary with a black spot.

Length 212 mm. Kaminoseki, in the sea. (Bleeker.) In young examples, the spines on the lower margin of the preoperculum are sharp and pointed, and the body is much shorter and deeper in comparison with the length of the head. In most all of the specimens the dark spot hidden between the maxillary and intermaxillary is evident.

No specimens were taken by us, although the species is said to be not rare in southern Japan. Our description is condensed from that of Dr. Bleeker, made from a specimen from Kaminoseki on the inland sea.

2. ACANTHOCEPOLA Bleeker.

Acanthocepola BLEEKER, Versl. Ak. Amsterd., VIII, 1874, p. 369 (*krusensterni*).

This genus includes those *Cepolidæ* in which the preopercle is armed with 4 to 8 blunt spines. The dorsal rays are simple and indistinctly articulate. Color bright red.

(ἄκανθα, spine; *cepola*.)

. Scales small, about 150 in a longitudinal series; D. 80, A. 76; no black dorsal spot, so far as known; preopercle with about 5 blunt spines; dorsal and anal fins margined with blackish .... *krusensterni*, 2.

aa. Scales minute, about 300 in a longitudinal series. Preopercle with about 7 blunt spines. D. 104; A. 105; a black spot in front of dorsal; dorsal not conspicuously margined with blackish; anal brown-edged .... *limbata*, 3.

2. ACANTHOCEPOLA KRUSENSTERNI (Schlegel).

SAKENOUWO (WINE-FISH); AKATACHIUWO (RED BLENNY); RINGUROTAIMATSU.

Cepola krusensterni SCHLEGEL, Fauna Japonica, Poiss., 1845,[a] p. 130 (not figured); Nagasaki.—BLEEKER, Verh. Bat. Gen., Ichth. Japan, XXV (1854), p. 39; Natursk. Tijds. Nederl. Ind., VI, 1854; p. 411; Verh. Bat. Gen., XXVI, Japan, 1854, p. 108; Act. Soc. Sc. Indo. Neerl., III, Japan, 1859, pl. II, fig. 1.—GÜNTHER, Cat. Fish., III, 1861, p. 488, Japan.—STEINDACHNER and DÖDERLEIN, Fische Japans, IV, 1887, p. 32; Tokyo.—ISHIKAWA, Prel. Cat., 1897, p. 32 ; Wakayama, Nagasaki.

Cepola hungta RICHARDSON, Ichth. China, 1846, p. 277; Canton.

Head $11\frac{2}{5}$ in length; depth $13\frac{3}{5}$; D. 80; A. 76; P. I 17; V. I-5; scales 164, 28 in a vertical series in front. Body very elongate, compressed, and covered with cycloid scales, which are very small on the anterior part of the body. Head longer than deep, compressed; eye larger than the snout, in the front of the head above, $3\frac{1}{5}$ in the head and $1\frac{1}{2}$ in the maxillary; snout very bluntly rounded, with the lower jaw produced; mouth very oblique, superior, and the jaws each with a single series of strong teeth; lips moderately fleshy; maxillary extending to below the middle of the eye; interorbital space flattened, $1\frac{1}{2}$ in the eye. Gill-opening large; the gill-rakers numerous, long, and slender; lower margin of the preoperculum armed with five blunt and rather broad spines. Dorsal, caudal, and anal confluent, the origin of the former a little in advance of the posterior margin of the gill-opening; dorsal low, more or less equal in height; caudal produced into a filamentous point; the origin of the anal at the tips of the pectorals, and, like the dorsal, the fin low; pectorals in the lower half of the body behind the gill-opening and about $1\frac{1}{3}$ in the head; ventrals below, a trifle behind pectorals and nearly equal in length, but produced into a point.

Color in spirits, almost uniform pale brown, the anal and caudal narrowly margined with blackish, with some spots a little deeper in color; no black spot on dorsal. In life bright cherry-red, with spots of rather deeper shade.

[a] According to Mr. Edgar R. Waite (in lit.), the dates of publication of the different parts of the volume on Fishes of the Fauna Japonica are as follows:

Decade I, pp. 1–20, 1842.
Decades II–IV, pp. 21–72, 1843.
Decades V–VI, pp. 73–112, 1844.
Decades VII–IX, pp. 173–269, 1845.
Decades X–XIV, pp. 173–269, 1846.
Decade XV, pp. 270–324, 1850.

Length $20\frac{5}{16}$ inches. Here described from Nagasaki specimens.

This species is common through Southern Japan, being far more abundant than *Cepola schlegeli*. Our specimens are from Tokyo, Misaki, Wakanoura, Onomichi, Nagasaki, Mogi, and Obama.

(Named for the traveler, Krusenstern.)

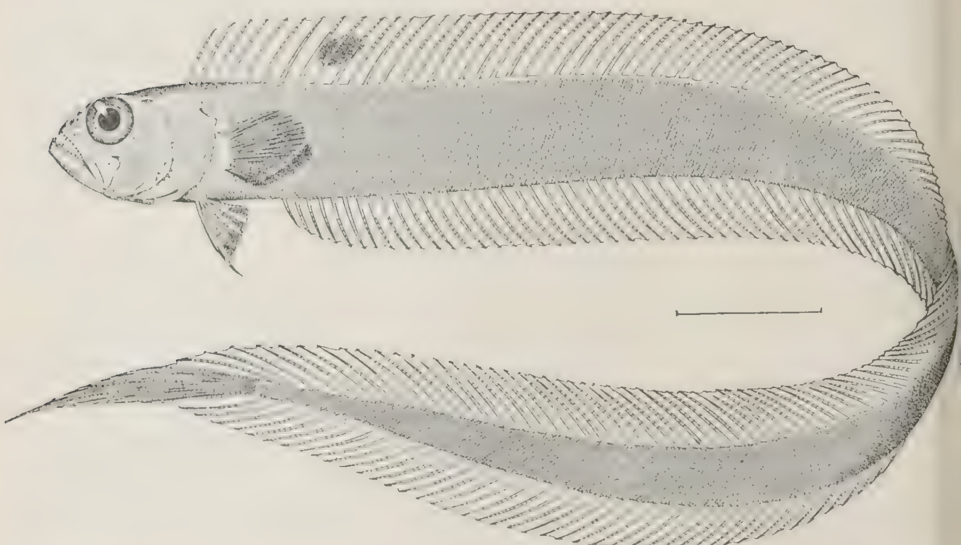
3. ACANTHOCEPOLA LIMBATA (Cuvier and Valenciennes).

Cepola limbata Cuvier and Valenciennes, Hist. Nat. Poiss., X, 1835, p. 402; Japan, after Krusenstern, pl. LX, fig. 2 (dorsal and anal bordered with deep red; a small black spot on front of dorsal; sides of body with red points).—Günther, Cat. Fish, III, 1861, p. 489, copied.—Nystrom, Svensk, Vet. Handl., 1887, p. 39; Nagasaki. (D. more than 80; head 9 in body.)

Cepola marginata Cuvier and Valenciennes, Hist. Nat. Poiss., X, 1835, p. 402; Japan, after Krusenstern, pl. LX, fig. 1 (brick red, dusted with dark points, fins bordered with brick red; dorsal spot black, smaller than in the preceding).—Günther, Cat. Fish, III, 1861, p. 489. Copied.

Cepola mesoprion Bleeker, Verh. Bat. Gen., XXVI, Japan, 1854, p. 109; Nagasaki.—Günther, Cat. Fish, III, 1861, p. 488.

Acanthocepola mesoprion Jordan and Evermann, Proc. U. S. Nat. Mus., XXV, 1902, p. 363; Giran, Formosa.



Acanthocepola limbata.

Of this species, distinguished by the very small size of the scales and the very large number of the fin rays, we have examined one specimen from Giran, Formosa. This specimen is certainly typical of *Acanthocepola mesoprion* and *A. limbata* is probably the same.

A description and good figure (see above) of this specimen has been published Jordan and Evermann.[a]

[a] Proc. U. S. Nat. Mus., XXV, 1902, p. 363.

A GENEALOGIC STUDY OF DRAGON-FLY WING VENATION.

By James G. Needham,
Of Lake Forest College, Lake Forest, Illinois.

INTRODUCTION.

This is a new study of one of the oldest subjects in entomology. It is an application of the methods of comparative morphology to the interpretation of some external characters universally employed in systematic work upon insects.

The richly veined wings of dragon-flies have been carefully studied by many able entomologists; their interesting peculiarities are well known; the homologies of the various parts of the wing have been determined throughout the order; and there already exists a considerable body of evidence as to the nature and extent of variation in venational characters. There has been as yet no serious effort to use these characters to determine genealogic succession within the order. It is the main purpose of this paper to translate the records of natural selection as written in the abundant characters of these wings.

At the outset I wish to acknowledge my indebtedness to the following gentlemen, who have all aided me generously: To Prof. J. H. Comstock, of Cornell University, I am indebted first of all for constant advice throughout the progress of this study; to Mr. Samuel Henshaw, of the Museum of Comparative Zoology, for free use of the Hagen Collection of Odonata during a stay of two months in Cambridge; to Dr. R. T. Jackson, of Harvard University, for similar privileges in the study of the fossil Odonata of the same museum; to Dr. P. P. Calvert, of the University of Pennsylvania, for the loan of valuable specimens; to Monsieur R. Martin, of Le Blanc, for the gift of specimens; and to Dr. S. H. Scudder, for the privilege of examining the types of fossil Odonata in his collection, and also some of his original unpublished drawings.

I. THE ONTOGENY OF THE VENATION.

Historical.

It is pleasant to find that the first contribution to the knowledge of developing veins was made by Dr. Hagen. In 1846 he published a little paper, a page in length, entitled Ueber die Bildung des Geäders der Libellen-flügel.[a] In this he wrote that by simply rubbing the expanding wing of a transforming dragon-fly between the thumb and finger the two membranes of the wing may be slipped apart, and it will be readily seen that the venation is double, i. e., developed alike in both membranes, and that the double network thus formed is united and exactly coincident along the courses of the wing tracheæ. At this day one who wishes to see the relation of veins to tracheæ can hardly do better than repeat this simple experiment. Thus he may at least see, a thing too little comprehended hitherto, that the tracheæ passing out from the body cavity into the wing cavity are essentially internal organs as compared with the cuticular (hypodermal) thickenings formed about them constituting the veins.

Oswald Heer appears to have been the first to use the wings of dragon-fly nymphs as an aid to interpreting the homologies of the adult venation.[b] He made no use of tracheæ, however, but only of the veins marked upon the exterior of the wing sheath, these being essentially the same as the veins in the adult only served to confirm him in an erroneous interpretation of homologies.

Roster first figured the tracheation of a nymphal wing.[c] His figure (of *Æschna cyanea*) was made to show tracheal distribution without reference to venation. It is in several points incorrect, and a chance remark in the text shows that Roster did not perceive the order which exists in the arrangement of the tracheæ.[d]

In 1888 Brauer and Redtenbacher published a paper on immature insect wings, using mainly a species of Æschna to show the fallacy of Adolph's theory of alternating convex and concave veins.[e] Of the

[a] Stettiner Ent. Zeit., VII, pp. 115–116. A similar paper by Dr. Hagen, Kurze Bemerkung ueber das Flügelgeäder der Insecten (Wien. Ent. Zeit., V, pp. 311–312), was called out in 1886 by the theories with which Adolph and Redtenbacher had encumbered their useful works upon the homologies of the wing veins in general. Then in 1889 he published (Spaltung eines Flügels um das dopplete Adernetz zu zeigen. Zool. Anz., XI, pp. 377–378) a similar article with a figure, showing the main facts set forth in all these papers.

[b] Heer, Oswald. Die Insectenfauna der Tertiargebilde von Oeningen und von Radoboj in Croatien. Neue Denkschr. Schweiz. Ges., XI, 1850, Libellulidæ, pp. 36–89, pl. IV.

[c] Roster, D. A., Contributo all 'anatomia ed alla biologia degli Odonata, Bull. Soc. Ent. Ital., XVII, pp. 256–268, 2 pls.

[d] Mandando in questo percorso cinque o sei diramazioni che innervano *intrecciandosi in vario modo*, la superficie dell 'ala. [The italics are mine.—J. G. N.]

[e] Ein Beitrag zur Entwickelung des Flügelgeäders der Insecten, Zool. Anz., XI, pp. 443–447.

branches of a single main trachea, some were shown to be incorporated into convex and some into concave veins. Thus disappeared the fundamental difference which had been assumed to exist between the two kinds of veins.

Brauer and Redtenbacher also affirmed that the homology of veins in remotely related insects is only to be determined by the study of their development—a suggestion which has until quite recently been generally commended in theory and more generally disregarded in practice.

Brogniart, in his Etude sur la nervulation des ailes des insectes,[a] figures both the tracheation and the venation in careful detail, and points out the close correspondence between the two. He fails to recognize the individuality of the veins and tracheæ, however, designating mere branches as independent veins, and he confuses the identity of one branch (*Rs*) by giving it a different designation in the two stages.

The foregoing papers have shown (without expressly stating) the following points: (1) The precedence of the tracheæ and the subsequent development of the veins about them, through hypodermal elevations becoming paired troughs, which by fusion become hollow tubes inclosing the tracheæ; (2) the difference in kind, and (3) the correspondence in arrangement between the two structures; and (4) the fact that simpler conditions are found in the earlier stages.

I have traced the development of the venation through a series of nymphal stages and have published recently, in collaboration with Professor Comstock, a preliminary account of it,[b] but must for present purposes review the matter more at length.

ONTOGENY IN GOMPHUS DESCRIPTUS.

For the present I pass by all points of histological structure, not as being uninteresting or unimportant, but as being unessential to the specific problem now in hand. I shall deal in this paper with facts that may be observed without the aid of sections, and, for the most part, with no special preparation whatever.[c]

Six principal tracheæ traverse the wing of a dragon-fly in all stages. These arise very early in the budding wing, springing separately from a longitudinal thoracic tracheal trunk which makes a slight bend outward to meet the base of the wing. These tracheæ and their cor-

[a] Recherches sur les insectes fossiles, etc., Paris, 1894. See especially pp. 204–208, and pl. VIII.

[b] Comstock, J. H., and Needham, J. G., The Wings of Insects, Amer. Nat., XXXII and XXXIII, 1898 and 1899; Art. Odonata, XXXII, pp. 903–911, 9 figs.

[c] The only preparation necessary to demonstrate the facts cited in the following pages is that of the wings of nymphs, which should be removed fresh, mounted quickly in glycerin jelly, and cooled suddenly (to retain the air in the tracheæ), and are then ready for observation.

responding veins will be designated, beginning at the anterior margin of the wing, by the following names and abbreviations:

1. *Costa* (*C.*).
2. *Subcosta* (*Sc.*).
3. *Radius* (*R.*).
4. *Media* (*M.*).
5. *Cubitus* (*Cu.*).
6. *Anal veins* (*A.*).

Typical branches will be designated by added numerals (as M_1, M_2, M_3, and M_4, designating from front to rear the branches of the media), except the posterior division of the radius, which has received the special name of "radial sector" (*Rs.*). Accessory and secondary branches will be designated by small letters added in the order of the development of the branches (as Rs_a, Rs_b, Rs_c, etc., for the secondary branches of the radial sector).

Fig. 1 represents the tracheæ in two early stages of the development of the nymphal wing of *Gomphus descriptus*. *A* is from a nymph less than one-fourth grown, the wing 1 mm. long. The tracheæ so closely resemble those in the developing wings of insects of many other orders there can be no doubt as to their homology. The radial sector is

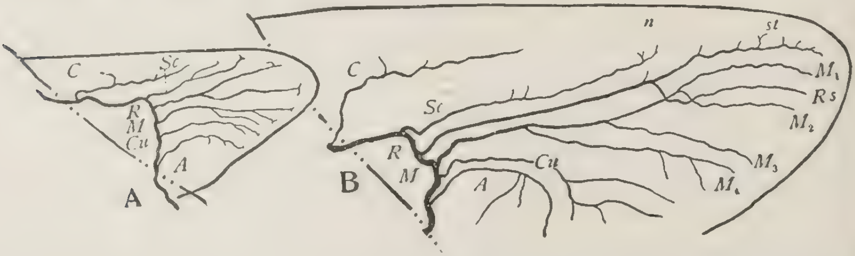


FIG. 1.—TRACHEATION OF THE WINGS OF TWO NYMPHS OF *Gomphus descriptus* BANKS, TWO EARLY STAGES. FOR EXPLANATION OF LETTERING SEE TEXT; ALSO, n = NODUS AND st = SUPERTRIANGLE.

simple—it is generally branched in other orders—and there is a single anal vein. In other orders there are oftenest three.[a] Otherwise the tracheæ are entirely typical at this stage. It is worthy of note that at this stage the wing is somewhat bilaterally symmetrical and the tracheæ are of almost equal size and length.

Fig 1. *B* is from an older nymph with wings 3 mm. long. The two marginal tracheæ are reduced or, rather, outstripped by their competitors, the wing has become quite unsymmetrical, and the radial sector has come to lie across the distal end of the media.

Fig. 2 represents the tracheation of both fore and hind wings of a grown nymph of the same species. The costal trachea is so dwarfed as hardly to enter the costal vein. The radial sector lies back of the two anterior branches of the media which it crosses. The other tracheæ, also, are assuming their definitive positions, and some of them are becoming strongly angulated at the middle and toward the base of the wing.

These three stages show clearly how the primitive insect wing has

[a] Probably the three terminal branches of this trachea represent the typical first, second, and third anal tracheæ fused together.

been modified to produce the Odonate type, in which the most anomalous thing is the crossing of the radial sector over two branches of the media. I can not now suggest even a possible reason why this should have taken place. It is apparently a character quite distinctive of the order Odonata.

A photograph of fore and hind wings of a grown nymph of the same species, showing the tracheæ and the veins together as they appear during the last nymphal stage, is reproduced in Plate XXXI, fig. 1. This will assist greatly in comparing the adult wings shown in fig. 3 with the preceding figures. This also shows that certain well-known features of the dragon-fly wing are due to strong cuticularisation

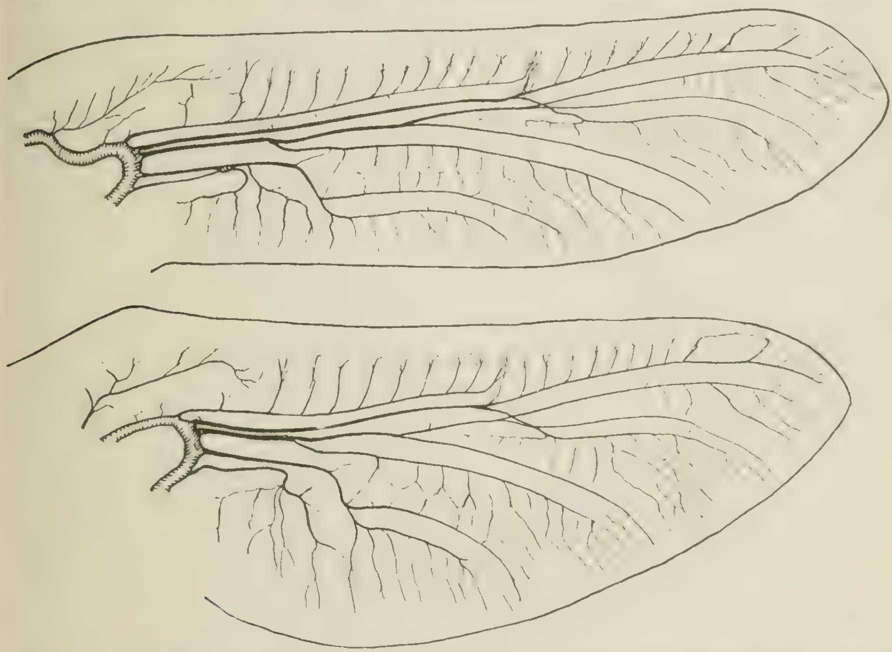


Fig. 2.—Fore and hind wings of a grown nymph of *Gomphus descriptus*, showing tracheæ. The permanent venation which shows distinctly at this stage is omitted.

between the tracheæ. Such are the stigma (*st.*), the nodus (*n.*), and parts of the arculus (*ar.*) and triangle (*t.*).

The radial sector. In the adult wing (fig. 3) the radial sector appears to be a branch of the media. It has always been so interpreted. The only indication of its connection with the radius is the persistent obliquity of an apparent cross vein between veins M_2 and Rs. This is in fact not a cross vein, but a part of the radial sector, while the longitudinal trunk (*br.*) extending proximally from this point to connect vein Rs with vein M_{1+2}[a] is not homologous with any principal vein, but is a secondary structure developed for mechanical advantage. There will be seen in the plate a recurrent tracheal twig preceding this structure.

[a]The plus sign is thus used as a convention for indicating united branches or tracheæ, the numerals it connects designating the branches conjoined.

Arculus and triangle. The radius and the media tend from the first to unite at the base, and in the adult wing appear to form a single vein as far as the arculus. But even in the adult wing this vein may be seen, as pointed out by Brogniart, to be composed of two, whose union he aptly compared to that of the barrels of a gun. Media suddenly bends away from the radius and is met by a cross vein from the cubitus, and thus the arculus is formed. A similar deflection of the cubital tracheæ just beyond the arculus makes a place for the development of the triangle, which is completed by two cross veins approximated upon vein M_4. Thus only the upper end of the arculus and the inner side of the triangle are formed from principal veins.

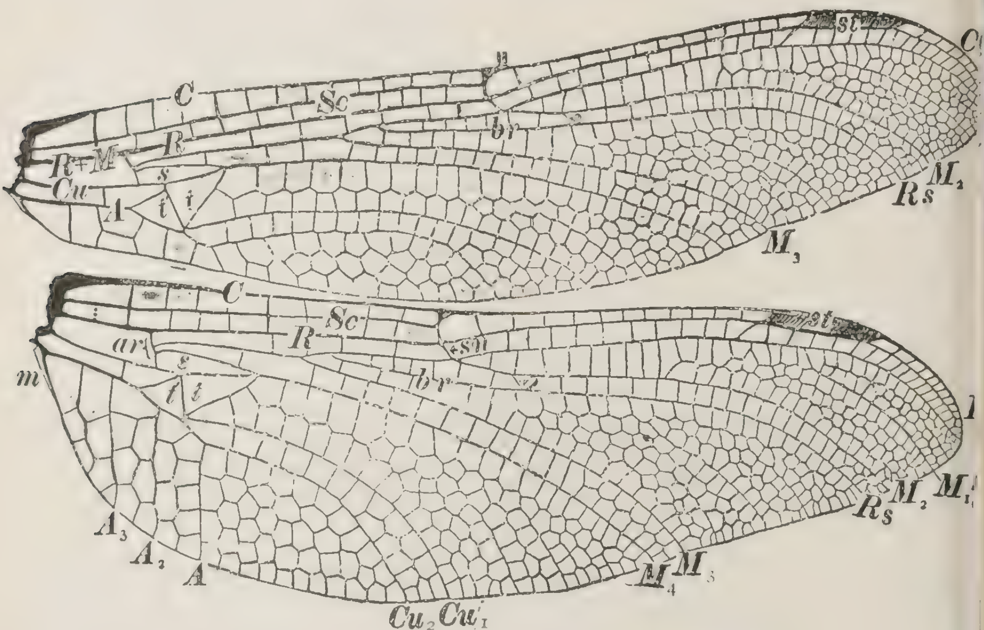


FIG. 3.—VENATION OF THE IMAGO OF *Gomphus descriptus*.

Tracheæ and cuticular thickenings thus combine to produce a unique insect wing, whose chief peculiarities arise from three transverse unions of its veins, at stigma, nodus, and arculus, respectively. Added to the usual thickening of veins and corrugation of membrane at the front border, these three unions make the part of the wing which cuts the air and supports other parts very strong. It will be observed that at the stigma but two or three veins are thus conjoined, at the nodus, more, and at the arculus (by means of parts accessory to the arculus) all the principal veins are bound together across the basal part of the wing. A line drawn from the outer end of the stigma to the hind angle of the triangle divides the wing into two areas, the anterior of which includes the strong framework of the wing, while the other is yielding membrane with weak venation, adapting the wing for that rapid sculling action in air by which forward motion is produced.

II. THE STUDY OF THE WING BY AREAS.

These three points of transverse bracing are also the points about which have played the forces which have evolved the dragon-fly wing. They are the points about which one can best follow the shifting of veins and tracheæ. In a study of genealogy one can hardly do better, therefore, than to discuss the wing by areas with these points as centers, drawing freely upon ontogeny, comparative anatomy, and paleontology for evidence of the changes that have taken place.

THE AREA OF THE STIGMA.

The stigma is developed upon the cutting edge of the wing at the point of greatest impact against the air. It would seem to serve the

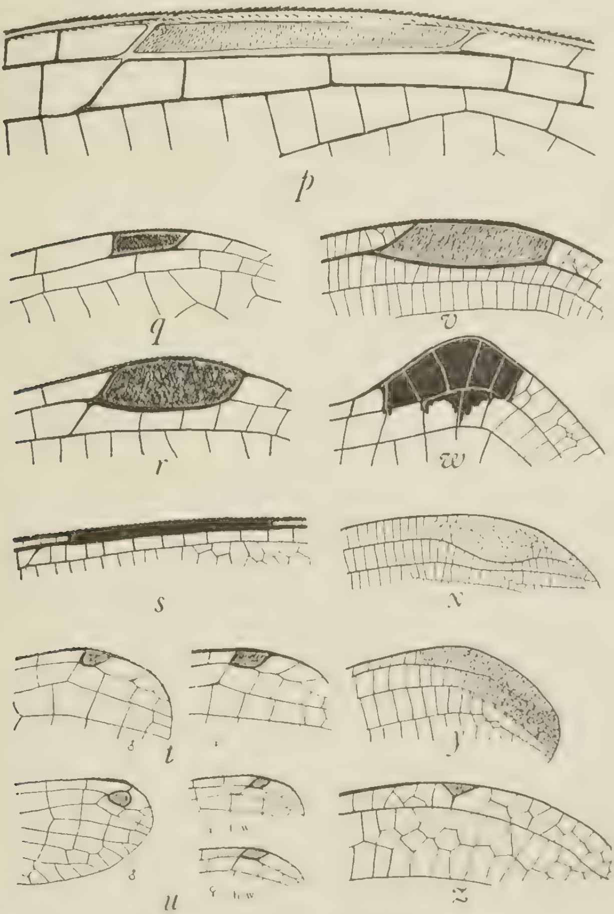


FIG. 4.—PTEROSTIGMAS; *p*, OF *Anax junius* DRURY; *q*, OF *Miathyria marcella* SELYS; *r*, OF *Neogomphus molestus* SELYS; *s*, OF *Uropetala carovei* SELYS; *t*, OF *Agrion mercuriale* CHARPENTIER; *u*, OF *Anomalagrion hastatum* SAY; *v*, OF *Thore gigantea* SELYS; *w*, OF *Mecistogaster lucretia* DRURY; *x*, *Calopteryx maculata* BEAUVOIS; *y*, *Microstigma* SP?; *z*, *Microstigma rotundatum*, SELYS, HIND WING.

double purpose of firmly uniting the veins of the front margin and of increasing the efficiency of the wing stroke by adding weight at this

striking point. Its shape and extent vary considerably and are often characteristic of groups; but the stigma seems not to contain in itself such characters for the critical determination of the course of specialization as are furnished by surrounding parts.

In the wings of the more generalized members of several families of Odonata there is between veins R_1 and M_1 a series of cross veins, several of which fall directly under the stigma, and all of which are nearly or quite perpendicular to the veins they connect. One of these cross veins which happens to lie at the proximal end of the stigma waxes stronger than its fellows, and is set in an oblique position in such way as to strongly brace the stigma against vein M_1. Three not remotely related Gomphinæ will illustrate the stages in the development of this strong brace from an ordinary cross vein. In *Epigomphus paludosus* (fig. 8) the proximal end of the stigma has no cross vein exactly in line with it; in *Cyclophylla diphylla* (Plate XXXIV, fig. 1) it is in line, but little strengthened; but in *Gomphus dilatatus* (Plate XXXIII, fig. 1) it has become a strong and evident brace. A parallel series might be pointed out among the Æschninæ (compare such genera as *Staurophlebia* (Plate XXXIX, fig. 2), *Basiæschna* (Plate XXXVII, fig. 2), and *Gynacantha* (Plate XXXIX, fig. 3), and the Agrioninæ offer another parallel, with the addition of an interesting feature, which is illustrated by a series of such genera as *Lestes* (Plate LIII, fig. 1), *Philogenia* (Plate LIII, fig. 4), *Argia* (Plate LIII, fig. 5), and *Nehallennia* (Plate LIV, fig. 8). In this series there is the same development of a brace from a cross vein; and, correlated therewith, a progressive angulation of vein M_1 at the base of this cross vein, forming a triradiate brace at that point.

An entirely different method of bracing the front of the wing at the stigma has prevailed in a few forms (*Thore*, fig. 4, *r*, etc.). The cross vein below vein R_1 is not utilized, but the two veins bounding the proximal and posterior sides of the stigma are deflected so as to meet vein R_1 in a strong Y-shaped brace, which, doubtless, serves a purpose analogous to that served by the other triradiate brace described above.

Fig. 4 shows at *p* the normal stigma of *Anax junius*, greatly enlarged. It shows, also, a few common forms of stigma, both braced and unbraced (*q* to *t*), and a few uncommon and more or less degenerate forms (*w* to *z*), which will be discussed under another heading.

THE REGION OF THE NODUS.

Here at once we come upon very peculiar wing features.

The nodus is the stout cross vein near the middle of the costal border of the wing, joining the costa, the subcosta, and the radius. It is traversed by a more or less evident suture, making a flexible and elastic joint which, without loss of strength in the parts which need

rigidity, would seem to allow more effective flexion of the distal parts of the wing.[a]

We have already seen the trachea *Rs* descending at the nodus and crossing tracheæ M_1 and M_2. The veins formed about these tracheæ bind them all solidly together. For convenience of reference we now designate that portion of the radial sector which unites the lower end of the nodus with the median vein as the *subnodus* (*sn.*) and the short oblique portion of the radial sector appearing as a cross vein behind vein M_2 as the *oblique vein* (*o*), and the trunk secondarily developed to connect the radial sector proximally with vein M_{1+2} as the *bridge* (*br*).

In the suborder Anisoptera we may then note that the radial sector fuses with vein M_2 for a little way, carrying the oblique vein a variable distance beyond the subnodus. The bridge is outlined in tracheæ of two very different types, which are almost characteristic of the two families of the suborder. (1) In all the Æschninæ of which I have had nymphs for examination the antecedent trachea is simple, and springs from the radial sector near what will be the distal end of the bridge (fig. 5) and extends in a direct line proximally toward vein M_{1+2}. (2) In most Libellulidæ the trachea which precedes the bridge springs from the radial sector near the origin of the latter (fig. 6), descends to the level of the bridge that is to be, forks, and sends its branches in opposite directions to meet veins M_{1+2} and *Rs* respectively. In the Macromiinæ, however, it is formed by a modification of the latter type, as shown for *Didymops transversa* in fig. 7 A. Fig. 7 B shows how, by a further division of the radial sector near its base, two oblique veins are formed in the Cordulegasterinæ and Petalurinæ. Compare also with fig. 28.

In the suborder Zygoptera, so far as known to me, trachea *Rs* appears as a branch of the media, the subnodus, while formed in the usual place, being destitute of a tracheal trunk. The Zygopterous nymphal wing figured herewith (Plate XXXI, fig. 2) shows that the trachea *Rs* has, in this (well grown) stage, at least, no direct communication with the radius at all. But if we compare the adult wings of the two suborders there can be no question as to the identity of the vein *Rs*, or of its homology in the two groups.

The explanation of this at first rather surprising state of the tracheæ I believe to be that the trachea *Rs* has been detached from the radius and attached to the media. There are everywhere between the principal tracheæ open channels of communication, formed by the

[a] This suture seems to have cut off the subcostal trachea, or else to have dwarfed and diverted its tips. In the cicada the subcostal trachea crosses the nodal suture; and doubtless it once did so in Odonata, for the adult vein extends a little way beyond in three living genera of Æschninæ (compare *Stauropthlebia*, Plate XXXIX, fig. 2), and was well developed beyond in the fossil genus *Æschnidium*. The nodus when present in other orders is nearer the wing apex than in the Odonata.

universal anastomoses of the smallest tracheoles. Any one of these

FIG. 5.—TRACHEATION OF THE NODAL REGION OF THE NYMPHAL WING OF *Anax junius* DRURY.

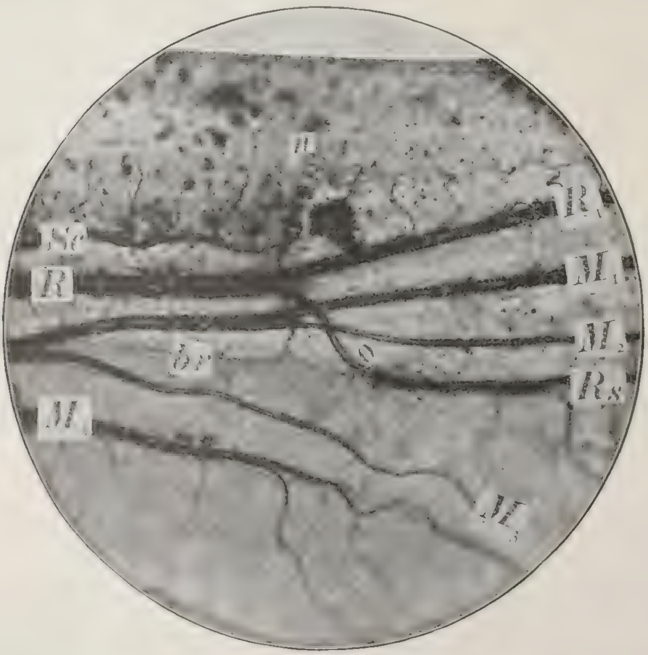


FIG 6.—TRACHEATION OF THE NODAL REGION OF THE NYMPHAL WING OF *Libellula pulchella* DRURY.

open air-passages might become enlarged, should necessity arise for

the entrance of the air from a new quarter. And I think that in this case the necessity may have arisen from the thinning of the wing cases of the slender Zygoptera, whereby the communication of the radial sector with the radius would be gradually pinched off. With the decrease of the air supply from the original source an increased amount must needs come from the medial trunk through tracheoles, some of which would be enlarged and one of which might finally attain the proportions of a tracheal branch, while the base of the radial sector would atrophy.[a]

Either the attachment of the radial sector to media was made at three

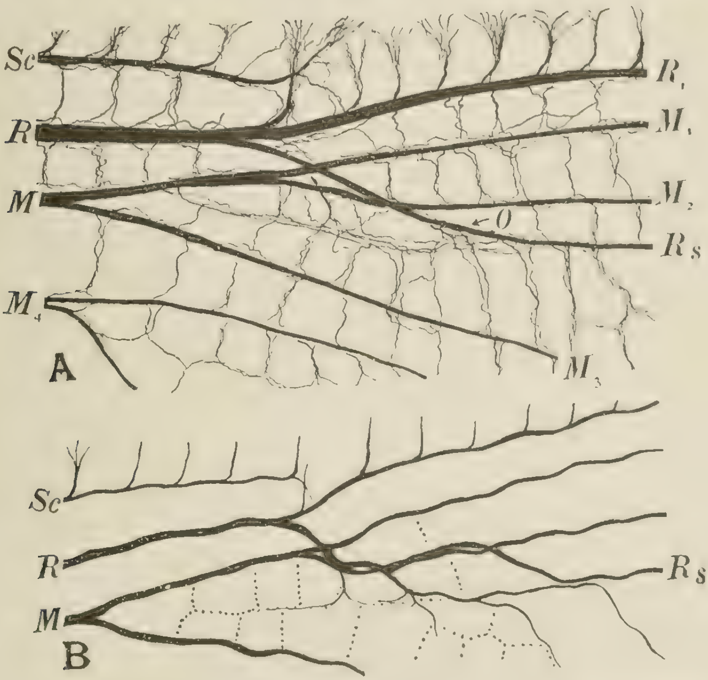


FIG. 7.—TRACHEATION OF THE NODAL REGION OF THE WING. *A*, OF *Didymops transversa* SAY; *B*, OF *Cordulegaster diastatops* SELYS; THE LATTER SHOWING THE MODE OF ORIGIN OF THE TWO OBLIQUE VEINS CHARACTERISTIC OF THE CORDULEGASTERINÆ AND PETALURINÆ.

different places, or else, since its reattachment, it has taken a different course in each of three different series within the suborder Zygoptera. In the Lestinæ we find it separating from vein M_3 far beyond the subnodus, the point of its departure marked by a more or less evident oblique vein, and a long bridge formed about numerous approximated tracheoles, mainly derived from neighboring branches of the media. In the Agrioninæ (*s. str.*) it separates from vein M_{1-2} near the nodus, and there is neither bridge nor oblique vein. In Calopteryx it sepa-

[a] Such shiftings of tracheal branches in insects wings are not unprecedented. Another instance will be cited further on in the case of the branches of the anal trachea. A case of the attachment of trachea M_1 to the radius in *Pieris* has been clearly indicated by Spuler (Zeitschr. f. Wiss. Zool., LIII, 1892, fig. 24, and Enderlein (Zool. Jahrb., Abt. f. Anat., XVI, 1902, pl. III, fig. 20.)

rates from vein M_{1-2} far to the proximal side of the nodus, and about in the more usual position of the proximal end of the bridge.[a] In this group bridge and oblique vein are lost; but similar parts are found, as will be noted later, extending the attachment of the radial sector to the media still nearer the arculus.

THE REGION OF THE ARCULUS.

Across the base of the wing a strong transverse union of all the principal veins is effected by means of arculus in the middle, triangle at the rear, and antenodal cross veins at the front. Distinct tracheal twigs precede the antenodals of the first (costal) series, while those of the second (subcostal) series are of independent cuticular origin.[b] Specialization is to be traced among these cross veins in their reduction in number and matching in position in the two series, and in the hypertrophy of some of them to form stout triangular trusses, which entirely fill, in section, the furrow between the costa and the radius. Two antenodals, some distance apart, are thus hypertrophied in most Æschnidæ, one at either side of the arculus; in the Thorinæ, but one, and that one meeting the arculus; in *Synthemis* alternate antenodals are thickened, but to a less degree. Their reduction in numbers will be discussed under the general subject of "cross veins."

We have already seen that arculus and triangle are formed where bends in the media and the cubitus, respectively, are met by strong cross veins. We have seen that the medial and the cubital tracheæ are at first straight or slightly curved as in other insects, and that the bending takes place late in nymphal life, at the time when the veins are forming. The genus *Anax* (Plate XL, fig. 3), while highly specialized in many ways, has preserved a rather primitive condition of the arculus. It is composed here largely of cross vein, which the media bends but slightly to meet, and the veins M_{1-3} and M_4 depart from it in straight lines. Media tends to descend the arculus, and the veins M_{1-3} and M_4, departing from it, become arched strongly toward the radius. In the Libellulidæ the branches of the media become fused at the base while arching upward. This may be traced in the stages attained by such genera as *Neocordulia* (Plate XLII, fig. 1), *Raphismia* (Plate XLIV, fig. 3), and *Pachydiplax* (Plate XLVII, fig. 1). The

[a] Indicating that in this group at least a recurrent tracheole, such as precedes the bridge in the Æschnidæ, may have developed into the basal attachment of the radial sector to the media.

[b] In other orders of insects cross veins are generally wanting from this space, and where present are very few in number.

It will be observed that the tracheal twigs which precede the antenodals of the first series are derived from the subcosta; those of the postnodals of the first series, from the radius. These tracheal branches are clearly the homologues of the longer anterior branches of the subcosta and the radius in the Neuroptera and the Orthoptera.

upward arching of the medial branches reaches its climax in some Calopteryginæ, when M_{1+2} after separating from M_3 again rejoins the radius: its basal part then appears as a cross vein, and when its trunk again frees itself it appears as a branch of the radius. *Pseudophaea* (Plate LII, fig. 3), *Calopteryx* (fig. 34), and *Vestalis* (fig. 41) have preserved the steps by which such condition has been attained.

In *Epigomphus* (fig. 8) there is a curious tendency for these medial branches to become conjoined just after their separate departure from the arculus.

In all these tendencies cuticularisation outruns tracheation: the veins become sharply angulated; the tracheæ much less so. This will be clearly seen by comparing nymphal (Plate XXXII, figs. 2 and 3) and adult (Plate XXXV, fig. 3) wings of *Lanthus parvulus*.

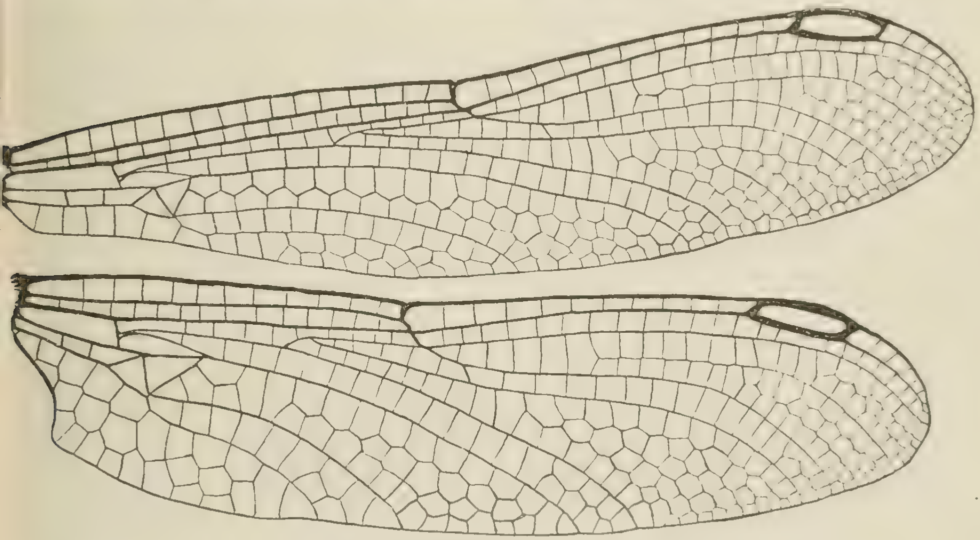


Fig. 8.—Wings of Epigomphus paludosus Selys.

The triangle has been called by several writers the "cardinal cell," and worthily, for it is a feature of cardinal importance in the Odonate wing.[a] We have already observed that it is ordinarily formed in *Gomphus* and others of the suborder Anisoptera, between an oblique deflected portion of the cubitus and two cross veins approximated upon the hindmost branch of the media. Between the proximal one of these two cross veins and the arculus is a narrow space which may conveniently be termed the "supertriangle" (s., of all the figures; also called elsewhere "supratriangular space").

The quadrangle of the Zygoptera. In the suborder Zygoptera triangle and supertriangle bear different relations to each other and to surrounding parts of the wing. Together they constitute a unit of wing structure. They are placed in line, not directed apart by an

[a] It is not always triangular, but the exceptions are few. The name is a very convenient one and in general use, and I use it in a strictly technical sense without regard to shape.

obtruding angle of the cubitus, and are oftenest confluent through the atrophy of the middle cross vein. To the four-sided figure, which together they always present, we will apply the technical term "quadrangle" (*q*, of all the figures; also called elsewhere "quadrilateral, and

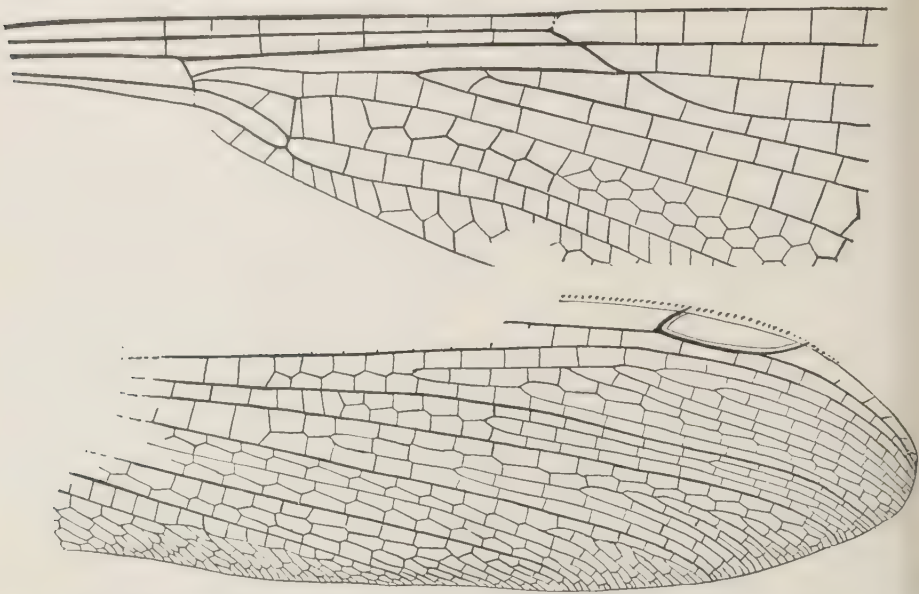


FIG. 9.—WINGS OF A FOSSIL, UNDESCRIBED, AGRIONID GENUS, IN THE MUSEUM OF COMPARATIVE ZOOLOGY.

quadrangular space"). The fossil Agrionid genus illustrated in fig. 9 offers easy transition from the conditions just seen in the Anisoptera to those of the Zygoptera, and renders homologies plain. Comparing this wing with the fore wing of *Tetrathemis* (fig. 10) with respect

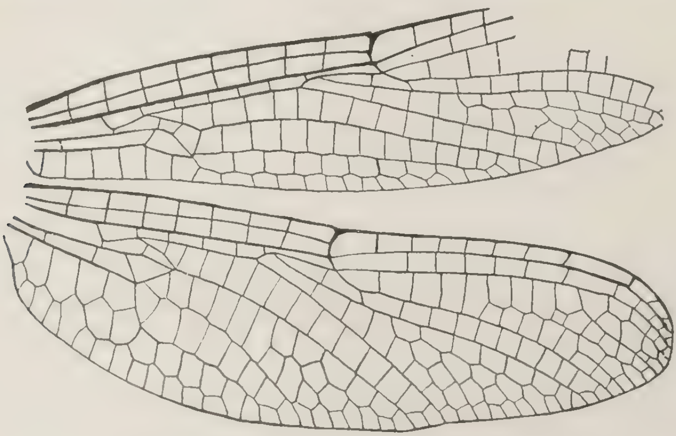


FIG. 10.—WINGS OF *Tetrathemis hyalina* KIRBY.

to the points in question, triangle and supertriangle are recognizable readily in both (though in *Tetrathemis* the latter is elongated and contains an extra cross vein), and both may easily be derived from ordinary rectangular cells.

In Agrionidæ (Plates LIII and LIV) the quadrangle is undivided, the middle cross vein being absent. In the Calopterygidæ (Plate LII) the middle cross vein is occasionally wanting, as in *Anisopleura* and *Epallage*, but in general the quadrangle is elongated and contains numerous extra cross veins, among which the identity of the typical one is lost. The quadrangle is generally rectangular in this family, but in *Hetærina* (Plate LI, fig. 4) it is widened distally and convex anteriorly; in *Thore* (fig. 35) and its allies, exactly the reverse. These facts are illumined when one sees what has been the behavior of the cross vein which terminates the quadrangle in this family. Vein Cu_2,

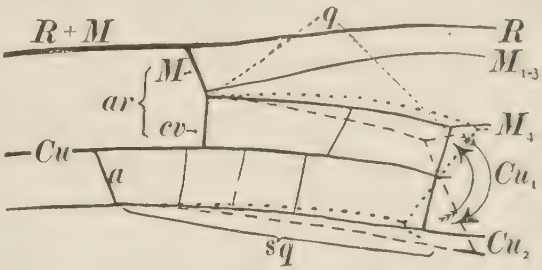


FIG. 11.—DIAGRAM ILLUSTRATING THE BEHAVIOR OF THE QUADRANGLE IN THE CALOPTERYGIDÆ. SOLID LINES, A SOMEWHAT PRIMITIVE QUADRANGLE; LINE OF DOTS, THE QUADRANGLE OF *Hetærina*; LINE OF DASHES, THAT OF RHINOCYPHA; ARROWS INDICATE THE OPPOSITE COURSE OF ROTATION. COMPARE WITH PLATES LI AND LII.

separating from vein Cu_1 at a right angle, and as suddenly bending again distally, sets off a transverse basal portion which is in direct line with this cross vein. The two thus joined rotate together about the hind angle of the triangle as an axial point, while the two forms of quadrangle described above are developing. In *Hetærina* (Plate LI, fig. 4) and *Lais* the medial end of the cross vein has proceeded distally, while the base of Cu_2 has been retracted; in *Thore* (fig. 35), *Rhinocypha*, *Lestes*, etc., the reverse rotation has taken place, as illustrated in the accompanying diagram (fig. 11).

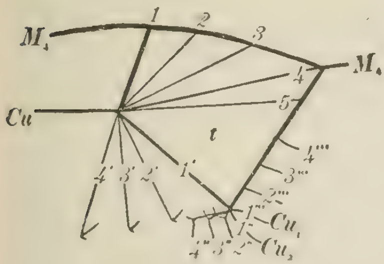


FIG. 12.—DIAGRAM SETTING FORTH THE BEHAVIOR OF THE TRIANGLE IN THE SUBORDER ANISOPTERA. THE HEAVY LINES BOUND A SOMEWHAT PRIMITIVE TRIANGLE, 1, 2, 3, 4, AND 5 ARE STAGES IN THE DESCENT OF THE UPPER CROSS VEIN. 1', 2', 3', AND 4' REPRESENT SUCCESSIVE STAGES IN THE RETRACTION OF THE CUBITUS AT THE TRIANGLE. 1'', 2'', 3'', AND 4'' REPRESENT STAGES IN THE RETRACTION OF THE BASE OF VEIN Cu_2. 1''', 2''', 3''', AND 4''' REPRESENT STAGES IN THE ASCENT OF THE VEIN Cu_1 UP THE OUTER SIDE OF THE TRIANGLE.

The triangle of the Anisoptera.—Returning now to the suborder Anisoptera, and to the triangle as an individual feature of the wing, we may follow with the aid of fig. 12 the changes that have taken place in it, bringing it from the condition of an ordinary rectangular cell to its present estate. It will be convenient to begin with a triangle hardly more generalized than that of the fore wing of *Tetrathemis*, and to follow the shiftings of its parts severally.

1. The angulation of the cubitus.—At the dividing cross vein of the quadrangle, the cubitus tends in all Anisoptera to form an angle, which pushes triangle and supertriangle out of line, thus destroying the unity of the quadrangle, in making of it two elements of wing

structure. The increasing angulation at this point may be followed in the fore wings of a series of Libelluline genera, such as *Microdiplax* (fig. 13), *Anatya* (Plate XLIV, fig. 2), *Mesothemis* (Plate XLV, fig. 3) and *Perithemis* (Plate XLIII, fig. 3). It is only a little less evident in such Gomphine genera as *Agriogomphus* (fig. 27), *Gomphoides* (Plate XXXIII, fig. 2), and *Gomphus* (Plate XXXIII, fig. 1). It will be observed that this deflection of the cubitus results in the widening of the space between veins M_4 and Cu_1 beyond the triangle. This may be seen in the aforementioned genera.

2. *The deflection of the middle cross vein of the quadrangle.*—It is this process that makes the distal half of the quadrangle triangular. Successive positions of the cross vein are shown at 1, 2, 3, 4, and 5 of figure. Such genera as *Tetrathemis* (fig. 10), *Anatya* (Plate XLIV, fig. 2), *Macrothemis* (Plate XLVI, fig. 1), and *Ephidatia* (Plate XLVII, fig. 2) exhibit these stages. A similar but less striking series will be seen in such Gomphine genera as *Agriogomphus* (fig. 27

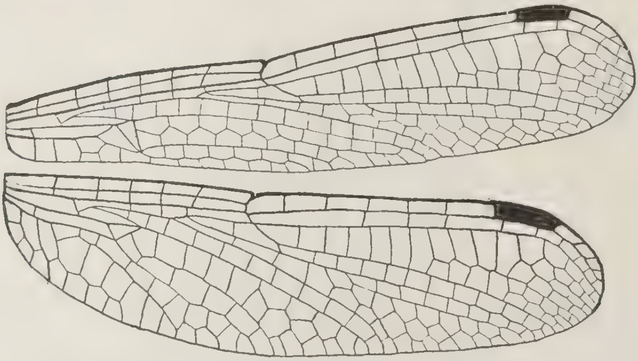


FIG. 13.—WINGS OF MICRODIPLAX DELICATULA SELYS.

Gomphoides (Plate XXXIII, fig. 2), and *Hagenius* (fig. 23). This cross vein has become greatly elongated in most Æchnidæ, resulting in the elongation of the whole triangle, as seen in such genera as *Gomphæschna* (Plate XXXVII, fig. 1), *Brachytron* (Plate XXXVIII, fig. 2), and *Nasiæschna* (Plate XXXIX, fig. 1). Thus this cross vein has come to lie in such position that it appears in the adult wing to be a continuation of the cubital trunk, and it has generally been so interpreted.[a]

[a] *Pentathemis membranulata* Karsch (Ent. Nachr., XVI, 1890, pp. 33–35) presents a somewhat unusual condition of this cross vein, in that it is declined to the maximum and bent upward in the middle at its junction with a cross vein in the supertriangle which has migrated outward upon it half the length of the triangle. This condition, very like that seen in the hind wing of Tetrathemis (fig. 10), only a little in advance of that, has resulted in the triangle, after once attaining triangular form, becoming again four sided. Clearly, it is not five sided as Karsch thought. His alternative explanation (same reference, p. 35), rejected because the triangle would not reach vein M_4 and the supratriangle would be in contact with the discoidal areolets—a condition seen in the hind wing of *Neocordulia* and *Hemicordulia* (Plate XLII, figs. 1 and 3) and in many Libellulinæ—is the right explanation, and the name *Pentathemis* is the result of a misinterpretation.

3. *The ascent of vein Cu_1.*—The cubital fork is in all Odonata at the ind angle of the triangle. When the distal end of the anal vein eets the cubitus squarely at this point, a struggle ensues between he branches of the cubitus for the maintenance of this strong point f support. In a series of genera Cu_2 wins, and Cu_1 is starved and rowded out, becomes much the weaker vein, and is forced to ascend he outer side of the triangle. This has happened in both fore and ind wings of *Pseudophlebia minima* (Plate XLV, fig. 1). The suc-essive positions it assumes are epitomized in the diagram; they may e verified in the hind wings of such genera as *Agrionoptera* (Plate XLIV, fig. 1), *Mesothemis* (Plate XLV, fig. 3), *Diplacodes* (Plate XLV, ig. 2), and *Microdiplax* (fig. 13).

4. *The descent of vein Cu_2.*—A happier solution of the struggle just nentioned is found when vein Cu_1 is left in possession of the hind ngle of the triangle, vein Cu_2 descending at a right angle from the fork, carrying the tip of vein A_1 with it for its own support. We have already seen that a very perfect adjustment of this sort exists throughout the Calopterygidæ, where vein Cu_2 appears as the direct continuation of vein A_1. Our diagram illustrates the manner in which this adjustment is brought about in the Libellulidæ. This will be better understood by examining the fore wings of such genera as *Agrionoptera* (Plate XLIV, fig. 1), *Anatya* (Plate XLIV, fig. 2), *Raphismia* (Plate XLIV, fig. 3), and *Ephidatia* (Plate XLVII, fig. 2).

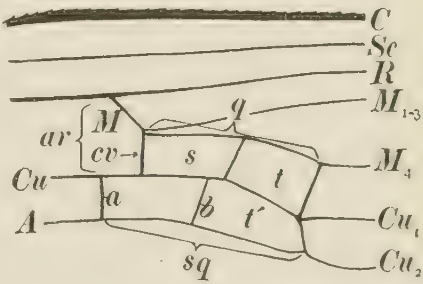


FIG. 14.—DIAGRAM SHOWING BASE OF TYPICAL DRAGON-FLY WING; SHOWING AT *a* AND *b* FIRST AND SECOND CUBITO-ANAL CROSSVEINS; SHOWING ALSO QUADRANGLE (*q*), SUBQUADRANGLE (*sq*), SUPER-TRIANGLE (*s*), TRIANGLE (*t*), AND SUBTRIANGLE (*t′*).

Differentiation between fore and hind wings at the triangle. Primitively, fore and hind wings of Odonata were alike, and the arculus was a little beyond the triangle in both, with the anal vein extending to the hind angle of the triangle (conditions still preserved in *Cordulegaster* (fig. 25)). The above diagram of these parts (fig. 14) will therefore stand for either wing.

In the space between the cubital and anal veins before the triangle are two crossveins which may fairly be considered typical, and which, because of the frequent necessity for reference to them, we will designate as the first and second cubito-anal crossveins (*a* and *b* of all the figures). The part of the cubital space beyond the first cubito-anal crossvein will be seen to lie directly beneath the quadrangle (which it much resembles). It may be conveniently designated as the "subquadrangle" (*sq*), and the part of this beyond the second cubito-anal crossvein as the subtriangle (*t′* of all the figures; called also, elsewhere, "subtriangular space" and "internal triangle").

Differentiation between fore and hind wings has been most com pletely carried out in the Libellulidæ,[a] and, fortunately, almost all th steps are still to be seen in living genera. In this family two ver different processes have operated in the two wings:

A. The procession of the triangle in the fore wing.—In all but th more generalized Libellulidæ the anal vein seems to run directly t the antero-internal angle of the triangle, while retaining in the hin wing its usual course to the hind angle. This is a puzzle; but the ke to the puzzle is found in the behavior of the second cubito-anal cross vein and the anal vein. The accompanying diagram (fig. 15) epito mizes what has taken place.

The anal vein formerly went directly to the hind angle of th triangle in the fore wing. Then, through the simultaneous deflectio of crossvein and anal vein, the latter came to appear forked a stag it has reached and still main tains in most Gomphinæ Then the basal part of th anal trunk was carried for ward into direct line wit the still further deflecte second cubito-anal cross veins, so that the latter ap pears as the continuation c the vein, and not at all as crossvein, while the dista end of the anal vein is almos lost among the crossveins o the proximal side of the tr angle. Thus it is that th anal vein seems to join th front angle of the triangl

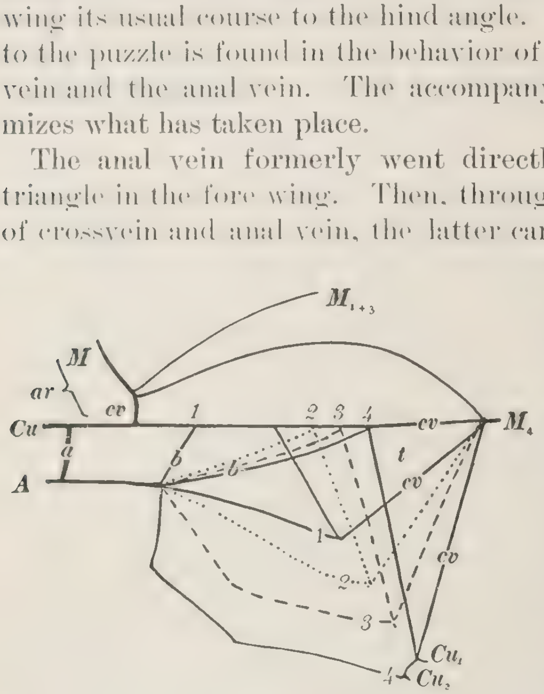


Fig. 15.—Diagram illustrating the procession of the triangle and the deflection of the anal vein and second cubito-anal crossvein in the fore wings of Libellulidæ. *a*, the first, and *b*, the second cubito-anal crossveins; 1, 2, 3, and 4, successive positions.

With the acquisition of new responsibilities, the second cubito-an crossvein has waxed stronger and longer, and has pushed the inn angle of the triangle toward the outer, making the triangle narrov and bringing about by this means its apparent remoteness from tl arculus. Such genera are illustrated in Plates XLIII, XLV, an XLIX, and show the steps in this process. Simultaneously tl

[a] Their differentiation in function was proved experimentally by Girard (186 Note sur divers experiences relatives a la fonction des ailes chez les insectes, An Soc. Ent. France, (4), II, pp. 153–162). His results that are of most interest he were gotten by simply clipping off one pair of wings at a time. Thus he showed th in *Agrion*, with fore and hind wings practically alike, flight is fairly well sustain with either pair of wings alone: Libellula can fly with the fore wings only, but wi the fore wings removed the hind wings alone will not sustain it in the air. I ha verified these results, using *Enallagma* and *Sympetrum*. I have also made some ne experiments to determine the utility of certain structures. Brief reference will made to my results farther on.

deflected portion of the cubitus (the inner side of the triangle) has been elongated, producing the very narrowly elongate triangle of *Libellula* (Plate XLVIII, fig. 3) and its allies.

B. The recession of the triangle in the hind wing.—The behavior of the triangle in the hind wing has consisted simply in its retraction through the successive position shown diagramatically in fig. 16, and illustrated in such genera as *Agrionoptera* (Plate XLIV, fig 1), *Raphismia* (Plate XLIV, fig. 3), *Uracis*, (Plate L, fig. 2), and *Pantala* (Plate L, fig. 3). Doubtless this recession of the triangle of the hind wing could only be advantageous in connection with the developments described under the next heading and discussed again farther on.

The anal area.—In the Odonata there is no anal furrow or suture, as in most other insects, sharply delimiting an anal field. The anal vein, except in a few fossil forms (*Isophlebia*, fig. 31, etc.), is solidly joined to the cubitus, as already shown. We now pass to notice the distribution of the anal branches in the small area back of the cubital deflection.

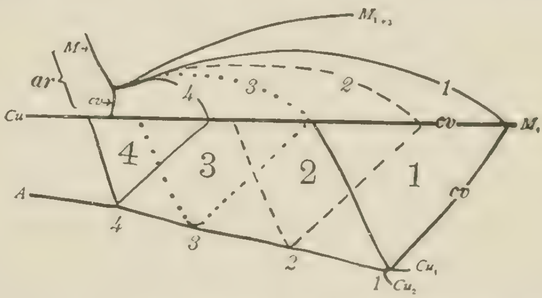


Fig. 16.—Diagram representing the recession of the triangle in the hind wings of the Libellulidæ, 1, 2, 3, and 4, successive stages.

Probably in the early Odonata the anal tracheal trunk occupied the position of the anal vein, well back of the cubitus. Ontogeny (see figs. 1 and 2) and analogy with insects of other orders would both support this view. But in such recent forms as I have had for study this anal trachea is closely approximated to the cubitus beyond the base, and, midway to the triangle, descends to the level of the anal vein, and sends branches both proximally and distally, about which that vein is formed (fig. 2, and Plate XXXI, figs. 1–3). Even in the thick wings of nymphs of Anisoptera the contorted position and decreasing size of the anal trachea indicate that, like the costal trachea of the opposite wing margin, it is suffering from lack of room; or, perhaps, outstripped by the intervening tracheæ that are better situated in relation to air supply. At least we find, especially in thin and narrow wing cases, the anal trachea dwindles, and loses successively all its branches, which then become incorporated into the cubital air system. The best developed anal trachea we have seen is that of *Anax* (Plate XXXI, fig. 3), in which it will be noticed that the terminal branch, A_1, is continued beyond its position of fusion with the cubitus in a recurrent position. In the hind wing of *Gomphus* (Plate XXXI, fig. 1) it will be observed that this recurrent portion is attached to vein Cu_2; A_1, apparently, wanting; A_2, strongly developed. In the fore wing of the same nymph A_1 has also been transferred to the cubitus, being

attached to the cubital trunk at the place where the anal vein bends strongly away from it. In all the Zygoptera I have been able to examine, all the branches of the anal vein have been transferred to the cubitus in both wings, the anal trunk being very greatly reduced or wanting (see Plate XXXI, fig. 2).

Such transference of the branches of the anal trachea lends the strongest support to the assumption already made regarding the transference of the trachea *Rs* to the media, in which case possible reasons for shifting and reattachment were much more clear.

The anal loop. Owing to such shiftings of trachea, owing also to the expansion of this region in some wings, occasioning the development of accessory tracheal branches and its reduction in others, causing all the branches to disappear, the homologies of those branches which are oftenest present are followed with difficulty. Two of them, however (designated as A_1 and A_2 in the figures), must be considered here, since they together form an inclosure, which becomes one of the strongest

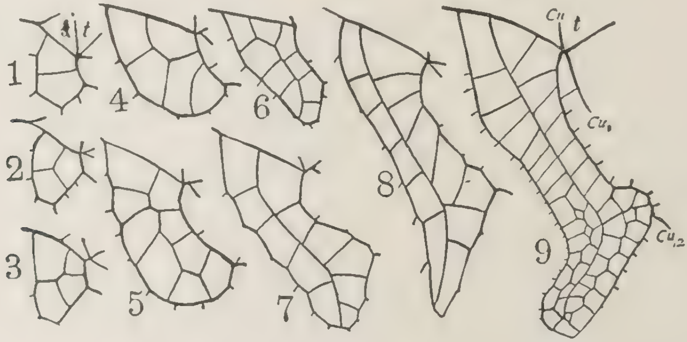


FIG. 17.—FORMS OF THE ANAL LOOP IN THE ANISOPTERA: 1, ANAL LOOP OF CYCLOPHYLLA DIPHYLLA; 2, OF *Gomphoides stigmatus;* 3, OF *Gomphæschna furcillata;* 4, OF *Gomphomacromia paradoxa;* 5, OF *Syncordulia gracilis;* 6, OF *Agrionoptera insignis;* 7, OF (?) *Nannophya maculosa;* 8, OF *Ephidatia longipes;* 9, OF *Hydrobasileus extraneus.*

of the supporting structures of the expanded anal area of the hind wings of the Anisoptera. This inclosure may fitly be designated as the *anal loop* (*al.* of all the figures). Fig. 17 will serve to show some of its more common and characteristic forms.

In some Aeschnine genera we find a supplemental loop (*al'*) developed between veins A_1 and Cu_{2a}. Fig. 3 of Plate XXXI shows how this is brought about; it is another accompaniment of the widening of the base of the wing. Since in the Libellulidæ the anal loop extends from vein A_2 to vein Cu_{2a}, it is to be considered as the equivalent of both loops in *Anax.* Of the characteristic foot-shaped loop of the commonest Libellulidæ the "toe" is of later development, and results from the concurrent elongation of veins A_2 and Cu_{2a} with the expansion of the hind angle of the wing.

After considering these changes severally, if we again compare fore and hind wing in any of the more specialized Libellulidæ we shall see

that only the part of the wing which lies back of the median vein has been affected by them. But that part has been modified profoundly; in it entirely different ends have been wrought out in the two wings, and by different means. The fore wing is characterized by greater modification of parts present in the primitive wing; the hind wing, by the greater development of new parts.

III. SOME GENERAL FEATURES OF THE WING.

VEIN SHIFTING AND VEIN DIFFERENTIATION.

There are two kinds of specialization occurring simultaneously in insect wings, not clearly delimited, but, nevertheless, distinct enough to enable us to understand in a measure the reasons for the success of both. First, there is the shifting of veins for the mechanical advantage of position and the development of strong cross veins to aid in maintaining favorable positions. These developments have occupied our discussion hitherto. We have seen that the course of specialization is traceable in each part, and we shall see further on that the parts, varying independently or being modified together, collectively furnish most excellent characters for interpreting the genealogy of the group.

Second, there is a specialization which is not confined to any particular part of the wing or to any particular structure, but which consists in the progressive differentiation between veins and membrane, in the concentration of strength-giving wing material within the supporting veins, and in the reduction of cross veins. Although less tangible, perhaps, and certainly less useful for tracing genealogies, this kind of specialization is none the less real. The first furnishes characters differing in kind; the second, only those differing in degree. The first, rather than the second, is characteristic of fossil species, some fossil forms having carried the shifting of veins already described to extremes unparalled at the present time. The second, rather than the first, is characteristic of those modern genera which belong to the cooler regions of the globe. The first is often accompanied by very abundant[a] venation. The second is indicative of keener competition in recent times and in temperate climates, necessitating greater economy of wing-building substance.

A comparison of the wings of *Neurothemis* (fig. 18) and *Tetragoneuria* (fig. 19), two genera of Libellulidæ that may fairly be taken as exponents of the two kinds of specialization, will make the difference between them clear. In *Neurothemis* we have venation "run wild"—the vein-building material scattered with great prodigality throughout the membrane, forming a very irregular and inconstant mesh work,

[a] One might almost say luxuriant. Possibly the advantage of the new position attained by the shifting of parts is so great that over development results from it at first.

such as was common to many early fossils of other orders and such as is still characteristic of the tegmina of the Locustidæ. In *Tetragoneuria*

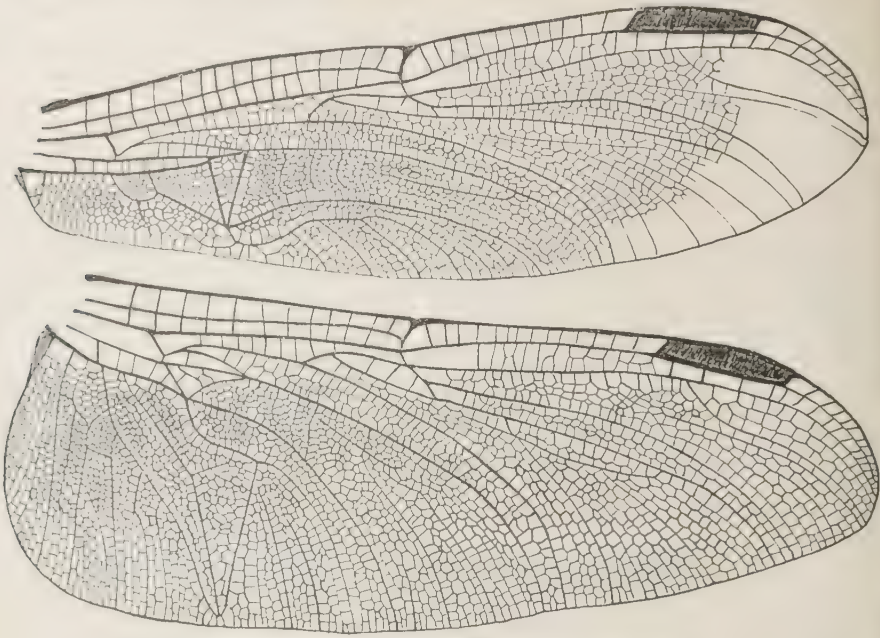


FIG. 18.—WINGS OF *Neurothemis oculata* FABRICIUS.

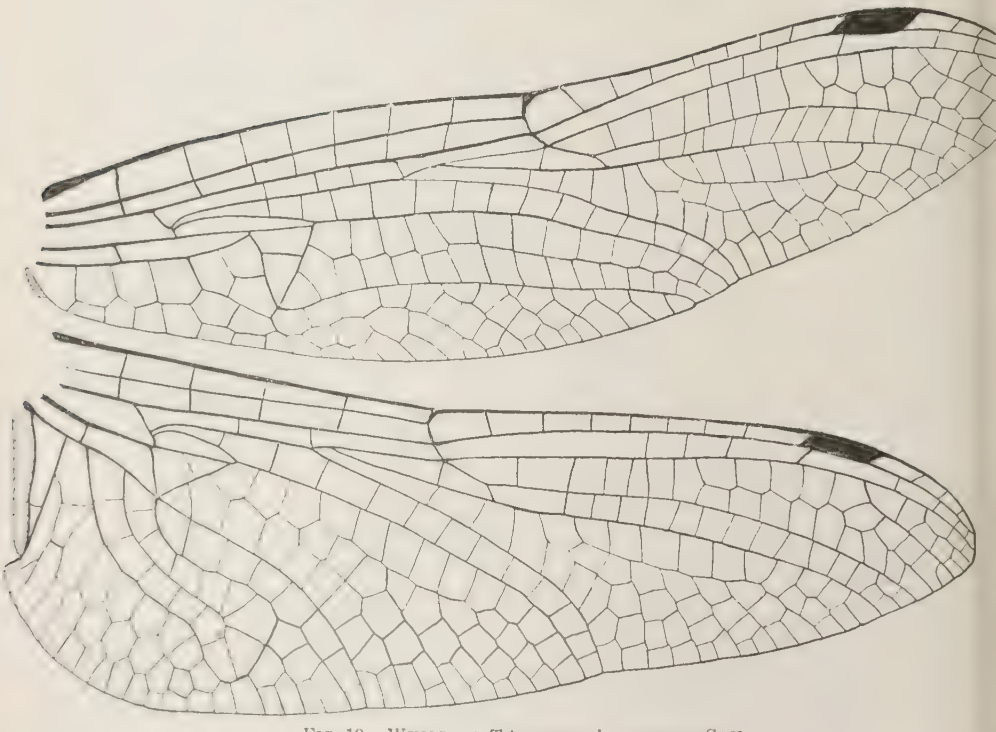


FIG. 19.—WINGS OF *Tetragoneuria cynosura* SAY.

order is wrought out of this seeming confusion in the wing membrane. The veins are strong, the membrane is thin and more transparent,

cross veins are reduced so as to leave those that remain in such position that each seems to bear its individual share in the stress upon the wing. Instead of a dozen, more or less, of inconstant cross veins in the space between veins R_1 and M_1 between nodus and stigma, as in *Neurothemis*, there are but three, and these three are constant, and so for other parts. In and about the triangle of *Neurothemis* are many veinlets which have been sacrificed to make the triangle itself stronger in *Tetragoneuria*. An actual count of the cells in a hind wing of *Neurothemis* gives the number 2,695; in a hind wing of *Tetragoneuria*, 265, the latter wing being at the same time a little larger. *Neurothemis* has far outrun *Tetragoneuria* in all those adjustments of parts in the region of the arculus, already described, as characteristic of the specialization of the Libellulidæ; but *Tetragoneuria*, having attained a fair measure of mechanically advantageous arrangement of parts, has attained success by disposing of its strength-giving wing material where it is most effective. *Tetragoneuria* is vastly superior in flight [a]—is, indeed, one of the fleetest and most agile of winged creatures.

CROSS VEINS.

The vein-building substance of which we speak is of couse hypodermis. The insect wing is essentially but a flat evagination of the body wall, with a few trachea grown out into it. During early development the hypodermis of the wing does not differ in any essential respect from that of other parts of the body. As elsewhere, it consists of a single layer of cells which secrete a protecting external layer of chitine. At the time of transformation, when the hypodermis of the two walls of the wing sac is bound together by fused internal processes, blood is forced out into the wing, greatly extending it laterally. The hypodermis is thus spread out in a very thin layer. As soon as a definitive layer of chitine is deposited, the hypodermal cells (which, of all cells known to me, possess the greatest capacity for speedy and extensive shifting and readjustment) begin to be segregated into groups along the lines of the veins that are to be, and there deposit additional chitine, which differentiates veins from membrane.

Doubtless in the earliest insect wings the segregation of the hypodermal cells was such as to give a membrane crowded with somewhat circular areoles, such as we find in the expanded lateral margins of the pronotum of the Tingitidæ, in the tegmina of the Locustidæ, in almost the entire wing of the fossil dragon fly *Æschnidium*, and in the wider spaces of the wing of *Neurothemis*. The principal veins first would become strongly marked by the accumulation of the hypodermal cells about the tracheæ. Cross veins would emerge from the meshwork, as they seem to be emerging in the wing of *Neurothemis*, in the spaces between veins R_1 and M_1, between M_3 and M_4, etc., by the dropping

[a] I venture this unqualified statement without having seen *Neurothemis* fly.

out of veinlets that are longitudinally placed; or, as illustrated in the following diagram (fig. 20).

A few strong cross veins for binding the longitudinal veins together would be developed first. In the wider spaces between the longitudinal veins the cells would take on hexagonal form as soon as necessity for economy in the disposition of vein-forming substance arose, and hexagons would, of necessity, fall into regular series or rows. This condition would early be attained—has been attained or surpassed by almost all living Odonata. Meanwhile the reduction among cross veins goes on apace, and the fundamental thing in this reduction consists in the better marshaling of the hypodermal cells at the proper moment of transformation.

This brings us to the practical point, that cross veins are constant in number and position only when they have attained individual responsibility—when each has its own share in the stress of the wing stroke. Utility determines survival among cross veins as among species. No better illustration could be found than the two cubito-anal cross veins before the triangle in the wings of the Libellulidæ. The first of these is formed, as we have seen, about the descending portion of the anal

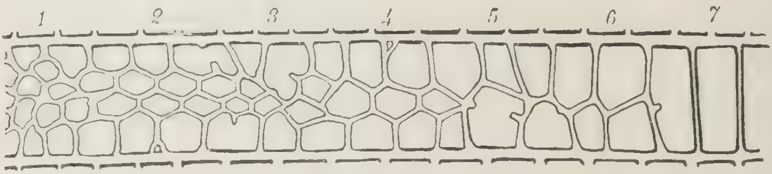


FIG. 20.—DIAGRAM ILLUSTRATING THE EMERGENCE OF STRONG CROSS VEINS.

trachea, and that is a sufficient reason why in the reduction of cross veins it never disappears. The second in the fore wing becomes braced against the front angle of the triangle and acquires new responsibility, which insures its preservation; one would as soon expect to miss those other cross veins which bound the triangle. But in the hind wing this same cross vein acquires no such importance—rather loses through the recession of the triangle any importance it may have had to begin with, so it early disappears. In the more generalized Libellulidæ it is always present; in the more specialized it is uniformly absent, but in a few, in this respect transitional genera, it is present or absent indifferently. Similarly in the more specialized Libellulidæ but one cross vein persists in the space which the bridge incloses, and there is a very good reason why that one never disappears—it is formed about the descending trachea which precedes the bridge.

Very similar are the antenodal and postnodal cross veins, of which so much use has been made in systematic work. In the fore wing of *Neuraeschna* the antenodals are more than forty, the number being inconstant; in *Pachydiplax* they are always six. In the hind wing of *Neuraeschna* the antenodals are about twenty-five; in that of *Tetra-*

goneuria they are four. Those antenodals which early chance become "matched" across both costal and subcostal spaces brace the deepening subcostal furrow better and are more sure to be preserved.

Then there is a reduction of cross veins which seems not solely directed toward strengthening those that remain, but rather toward clearing out of spaces between the points of transverse union of longitudinal veins.[a] This clearance takes place in different places in Libellulidæ and in Gomphinæ, correlated with the difference in shape and position of the triangle in the two groups. In the former the cross veins disappear (see *Pachydiplax*, Plate XLVII, fig. 1) from the spaces adjacent to the subnodus and the oblique vein and under the stigma. In the latter (see *Gomphus dilatatus*, Plate XXXIII, fig. 1) from the spaces just beyond the arculus. In the Æschninæ, with triangles similarly disposed, while the cross veins do not actually disappear just beyond the arculus, we find sometimes (as in *Anax*, Plate XL, fig. 3)

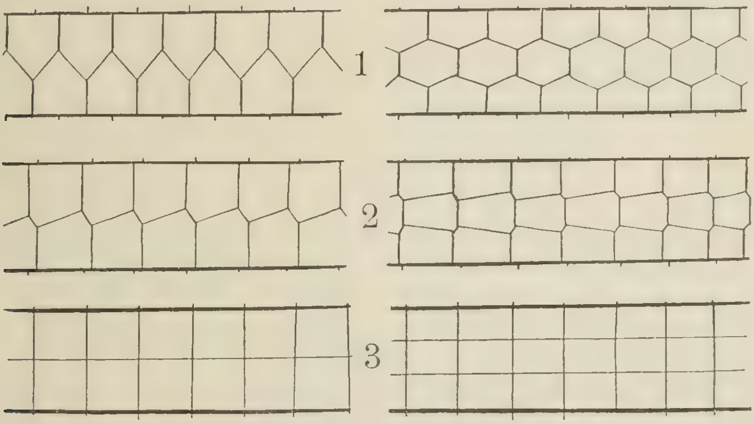


FIG. 21.—DIAGRAM SHOWING HOW HEXAGONAL CELLS BECOME RECTANGLES AND HOW CROSSVEINS BECOME MATCHED IN TRANSVERSE LINES ACROSS THE WING.

all the veins on the anterior side of the base of vein M_1, between it and the radius, so dwindled that little more than thin membrane remains. This is much more evident in the actual wing than in the figure.

We have already referred to the matching of nodal crossveins. In the Agrioninæ this process is carried so far that all the crossveins of the body of the wing become arranged in transverse lines. A comparison of the wings of *Archilestes* (Plate LI, fig. 6), *Lestes* (Plate LIII, fig. 1), *Argia* (Plate LIII, fig. 5), and *Nehallenia* (Plate LIV, fig. 8) will illustrate the progress of this tendency.

[a] Allowing, perhaps, for readier flexion of the portion of the wing posterior to the cleared spaces, though of this I am not sure. In Myrmeleonidæ (Plate XXXVI fig. 2) subcosta and radius are strongly bound together at base and at stigma, while the long narrow space between is free from cross veins. It would seem, since the wing is easily flexed behind this space, the costal margin remaining rigid, that an imaginary axis of flexion joins the two strong yet elastic terminal points of union.

The accompanying diagram (fig. 21) shows the steps by which crossveins may be brought into line. All these steps may be seen in the wings of Agrioninæ represented in the plates and better still in fig. 9.

In Calopterygidæ crossveins are so numerous it seems to have been of more moment (at least in Calopteryx and its nearest allies) that the longitudinal lines of crossveins should become straight, allowing the longitudinal furrowing of the base of the wing to be extended to the margin.

SECTORS AND SUPPLEMENTS.

The areolæ, or cells, of the wing membrane are potential hexagons. Where bordered on one side by a straight vein they are converted into pentagons by the elimination of one angle; where included in a single row between two veins they become quadrilaterals, through the elimination of two angles. Even in the broader areas of the wing their hexagonal regularity is early disturbed by two more or less distinct means: (1) by the development of new tracheal branches, which penetrate into the broader spaces, straightening out certain broken lines of crossveins and converting their bordering hexagons into pentagons; (2) by the development of longitudinal veins, independently of the tracheæ—veins which traverse the same spaces in a direction generally more or less transverse to that of the accessory tracheæ and complete the havoc of the hexagons. By the first means are produced extra branches of principal veins, which so appear in the adult wing. Some of the most important of these are designated M_{1a}, Rs_a, Cu_{2a}, etc., in the figures. By the second means are developed curved veins, which are generally opposed in position to the principal veins bounding the wider spaces anteriorly. These may be called *supplements*. Both are well shown, and the difference between them is clearly demonstrated by Plate XXXII, fig. 1 of *Anax junius*. The principal trachea shown is the radial sector, whose branches are accessory; the strong, developing vein that sets across them, bending toward the radial sector at both its ends, is the *radial supplement* (*R. suppl.*, of all the figures). It will be seen to be a purely cuticular vein, without trachea of its own. Behind vein M_4 is an exactly similar vein, the median supplement (*M. suppl.*, of all the figures). Behind vein M_1 and proximal to vein M_{1a}, though often joined to the latter, is another, the apical supplement (*ap. suppl.*), well shown in *Tramea* (Plate XLIX, fig. 3) and its allies. From the outer side of the triangle there starts another, the trigonal supplement (*trig. suppl.*) well shown in *Hagenius* (fig. 23), and in most Æschninæ (Plates XXXVII–XL).

Both supplements and extra branches, being relatively recent acquirements, are well developed only in the more specialized members of the several groups.

UNEQUALLY DEVELOPED WINGS IN THE SAME SPECIES.

1. The specialization of fore and hind wings to an unequal degree, vhen both (or the parts concerned of both) are following similar lines.—\ single illustration of this will suffice. In *Chalcopteryx* (fig. 22) he fore wing has in several points outrun the hind. For instance, ein M_2 separates from vein M_1 in the hind wing at the subnodus, as s usual; but in the fore wing M_2 has fused with M_1 for the space of everal cells' length beyond the subnodus. Again, in the space etween veins M_1 and M_2 there are a number of interpolated sectors, ll of which are independent of the veins in the hind wing, but in the ore wing the next to the longest of these has become attached to vein M_2 in such position that M_2 now appears forked. It will be seen at a

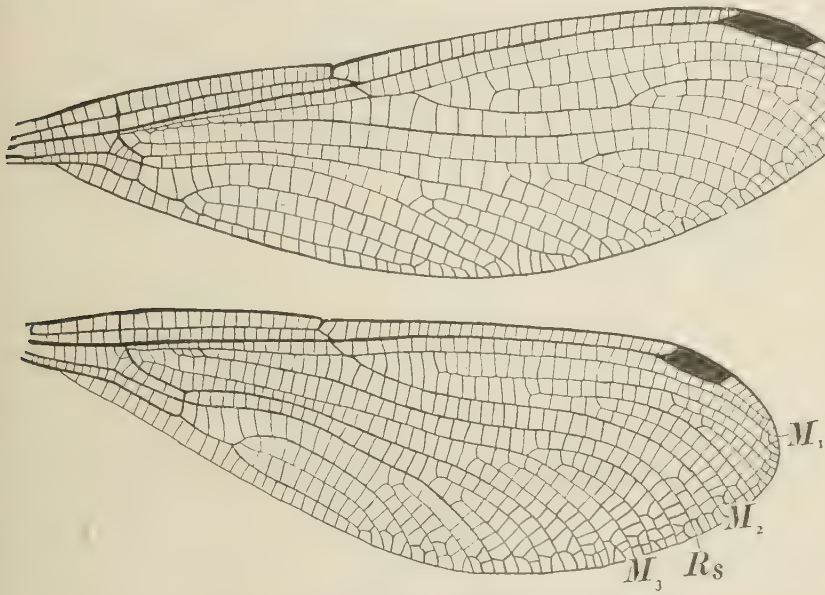


FIG. 22.—WINGS OF *Chalcopteryx rutilans* RAMBUR.

glance that the anterior branch of this fork is the same thing as the independent sector occupying the same position and relations in the hind wing. First, a broken line of crossveins became straightened out longitudinally to form the sector; then, one of the crossveins lying below its proximal end in the fore wing became declined to brace the sector against vein M_2. But the bracing of the wing tip did not stop with this. The upper branch of the fork has acquired a lesser fork of its own, whose anterior branch is in like manner developed out of a still shorter sector, which has remained independent in the hind wing. Again, the longer of the two sectors in the space between veins *Rs* and M_3 in both wings become attached to vein M_3; a symmetrical fork has thus been developed in the fore wing, but in the hind wing the adjustment is still imperfect.

2. Unequally developed wings in the two sexes.—The wings of the male often outrun those of the female. The best-known instance is the frequent angulation of the anal area of the hind wing in the male, the hind angle of the female always remaining rounded. In *Hagenius* (fig. 23) it will be seen that the difference in conformation of the anal angle has slightly affected the form of the anal loop also.

In that part of the Calopterygine series in which the stigma is lost it is retained longest in the females.

In *Agrion* (fig. 4, *l.*) it retains a much more primitive form in the female. The curious stigma of the fore wing of the male of *Anomalagrion* (fig. 4, *n.*) has outstripped that of the hind wing, but even the latter is somewhat less primitive than either stigma in the female.

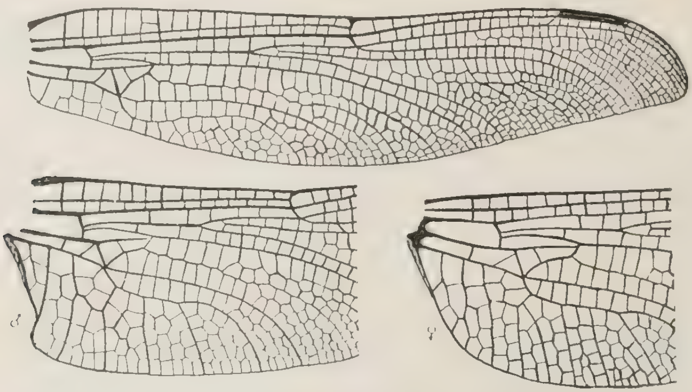


FIG. 23.—WINGS OF *Hagenius brevistylus* SELYS.

The reason for the greater specialization of the wings in the male is, of course, so well known as to need only passing mention. The males, and not the females, seek their mates and compete for them upon the wing, often amid great rivalry.

SUMMARY OF THE MORE GENERAL TENDENCIES OF VEIN EVOLUTION WITHIN THE ORDER.

The facts of ontogeny and comparative anatomy hitherto presented seem to warrant a number of conclusions as to the development of the several parts, which conclusions may be expressed in tabular form as follows:

Generalized condition.	*Developmental tendencies.*
Subcosta long; nodus remote from wing base.	Subcosta becoming shortened and the nodus retracted.
Antenodal and postnodal cross veins numerous, weak, irregular (not matched), and none of them hypertrophied.	Antenodal and postnodal cross veins becoming reduced in number, stronger, more regular, sometimes matched in position or differentiated among themselves.
Stigma without special support.	Stigma becoming supported, proximally by a brace vein (hypertrophied cross vein), and distally by a sector (M_{1a}).

Bridge weakly or incompletely developed; oblique vein remote from the subnodus.	Bridge becoming strong and directly attached to vein M_{1+2}; oblique vein, retracted toward the subnodus.
All principal veins straight or gently curved and evenly forking.	Some principal veins becoming strongly angulate at points of special bracing.
Media at the top of the arculus.	Media descending the arculus.
Veins M_{1-3} and M_4 at their departure from the arculus, separate and straight.	Veins M_{1-3} and M_4 becoming fused, or strongly arched upward, or both.
Triangle, supertriangle, subtriangle, etc., ordinary quadrangular areoles (perhaps traversed by weak cross veins).	Triangle, etc., becoming strong and highly differentiated inclosures.
Cubitus somewhat symmetrically forked.	Cubital fork becoming strongly unilateral.
Anal angle of the wing unsupported.	Anal angle becoming supported by the junction of veins Cu_2 and A_1 and, sometimes, by the development of an anal loop.
Cross venation dense, irregular, and inconstant.	Cross veins becoming fewer, stronger, more definite and regular, and the membrane, thinner.
Fore and hind wings alike.	Fore and hind wings differentiating (1) by following parallel paths with unequal speed, and (2) by following different paths.

IV. LINES OF SPECIALIZATION.

Hitherto we have been discussing wing characters more as individual entities than as mutually dependent parts of a single organ. The illustrations of the steps in the development of each, drawn from adult wings, have been selected arbitrarily, and have not always been drawn from a single line of development. They have served the purpose of illustrating in a general way the progressive modifications of each part, confirming the ontogenetic record. In their application to this end we have necessarily overlooked the lesser individual peculiarities of each. Correlated characters varying independently preserve, some here, some there, bits of the ancestral record, but with more or less of individual alteration of it. It is probable that every one of the characters discussed in this paper would be found on closer study to possess distinctive features in each genus—earmarks of the genus. This, of course, applies not to wing parts alone, but to every other part as well.

We come now to consider these same characters in their ensemble. Their individual records, of course, do not agree. Did they agree, we should have a single lineal series, very well adapted to book making. We should have a wing exhibiting the generalized characters just mentioned with which to begin the series. But while it has been easy to show by concurrent ontogeny and comparative morphology that

the characters there presented are relatively primitive for the group, and while each of these characters is exhibited in some of the more generalized forms, it is quite impossible to find a single wing embodying them all. Let us therefore now carefully compare the several records and discover, if we may, the history of the principal Odonate wing types.

THE FIRST DICHOTOMY.

The first dichotomy has been already indicated, or, at least, implied. Aside from the crossing of the radial sector, respecting which all dragon-fly wings are in essential agreement, the quadrangle has certainly played the most important rôle in the evolution of these wings. Upon the quadrangle two distinct tendencies have operated, producing the suborders Zygoptera and Anisoptera. In the former the tendency has been to preserve the quadrangle as a unit of wing structure, to continue vein Cu_1 outward from it in direct line, and to set off Cu_2 squarely upon the distal end of vein A_1. In the latter the tendency has been to divide the quadrangle into triangle and supertriangle, and to differentiate between fore and hind wing. Supplements are developed only in the latter, while the tendency toward the matching of cross veins and the reduction of the base of the wing are characteristic only of the former.

SUBORDER ANISOPTERA.

Again, in the two great families of this suborder two dominant tendencies are almost equally plain. In the Æschnidæ these are toward (1) the similar elongation of the triangle in both wings; (2) the development of strong supplements; (3) the hypertrophy of two antenodal cross veins; (4) the development of a brace to the stigma, and (5) the angulation of the hind angle of the hind wing in the males. In the Libellulidæ there is the single, more definite, and more exclusive tendency, already discussed, toward the differentiation between fore and hind wings at the triangle.

A. *Æschnidæ*. The family Æschnidæ is a bundle of remnants. In it are found no less than eight fairly distinct types of venation. The types represented by *Heterophlebia*, *Stenophlebia*, and *Æschnidium*[a] are extinct. That of *Petalura* was much more abundant in past times than now. *Chlorogomphus* and *Cordulegaster* are represented by but a few isolated species. Only the groups of *Gomphus* and *Æschna* are dominant at the present time. In some cases, therefore, there is no

[a] Attention should be called here to the peculiar and altogether isolated type of venation found in *Æschnidium*. In wings, otherwise like those of the Æschnidæ, the shifting of the anal vein up toward the inner angle of the triangle is completely carried out in both fore and hind wings. In this, and also in the secondary developments for supporting the expanding anal angle, *Æschnidium* far outran all living forms. In the matter of differentiation between veins and membrane, however, and the reduction of cross veins, it remained very generalized indeed.

ıterial to be had for tracing genealogies, and we will attempt to pint out only the more important venational features, comparing tem with the conditions we believe to be primitive for the order.

Chlorogomphus.—This (fig. 24) is an isolated living type, specialized i the extensive differentiation between fore and hind wing by the evelopment of an expanded anal area upon the latter, generalized in is unbraced stigma and in its retention of cross veins in the space efore the arculus. It parallels *Macromia moorei* in the peculiar form (its anal loop, and *Hemianax ephippiger* (Plate XXXVI, fig. 3) in ie circuitous course of vein Cu_2. It is unique among the Odonata nown to me in that the triangle of the hind wing has been elongated ansversely to the axis of the wing, while that of the fore wing is quilateral.

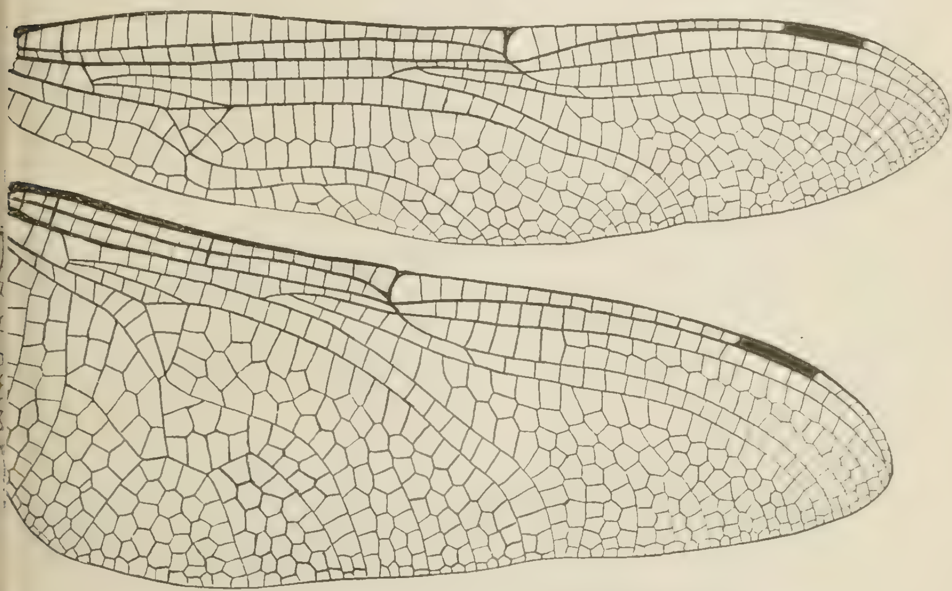


FIG. 24.—WINGS OF *Chlorogomphus magnificus* SELYS, FEMALE.

The Cordulegaster group.—This small group has retained some decid- edly primitive features. Anal vein and second cubito-anal cross vein nave retained their primitive position and relations in both wings. The triangles are alike, and only moderately elongated. No supple- nents are developed; and there is no brace to the stigma, or only a very imperfect one in *Petalia* and its allies. There is, however, a mod- erate enlargement of the base of the hind wing, and this becomes ungulate in the males. *Cordulegaster sayi* (fig. 25) and *Phyllopetalia apicalis* (fig. 26) represent the divergence of the group; there is uni- formity in the more important wing characters. There has been a slight development of accessory branches upon the radial sector, and in the wing of *Phyllopetalia* will be noticed the undulate course taken on by veins M_2 and Rs, and by M_3 and M_4; but the reduction of redun-

dant cross veins, and the strengthening of the principal veins and brac seem to have been the means whereby these wings have attained thei goodly measure of efficiency.

Æschnina. We come now to a group that is flourishing in our ow time the world over. It contains the largest of our common drago

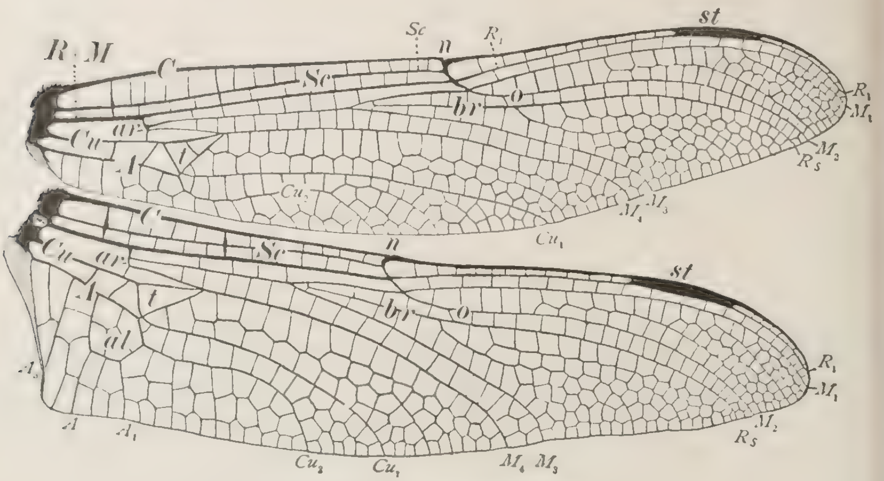


FIG. 25.—WINGS OF *Cordulegaster sayi* SELYS.

flies, all strong-flying species, composing many genera. In the mor specialized genera are many species. There is great variety in th details of the luxuriant venation of the group. Here, then, we hav opportunity to apply the facts of development previously outlined t the unravelling of a bit of genealogic history.

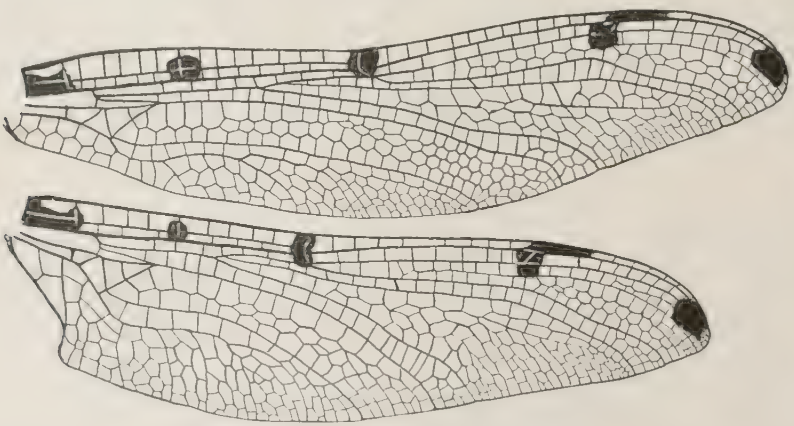


FIG. 26.—WINGS OF *Phyllopetalia apicalis* SELYS.

The most characteristic features of the Æschnine wing are (1) the approximation of veins M_1 and M_2, brought about by the bending forward of vein M_2 at the stigma, (2) the development of strong and broadly curved supplements, and (3) the elongation of the triangles in the direction of the axis of the wing. These will be seen in their best development in such genera as *Æschna* and *Anax* (Plate XL.)

Doubtless, the most generalized group within the Aeschnine series is composed of *Cymatophlebia* (fossil), and *Gomphæschna* (Plate XXXVII, fig. 1), which have the triangle little elongated, all supplements but little developed, the anal loop small and compact, with no supplemental loop, and the anal angle of the hind wing, therefore, not greatly dilated, but which always have the stigma braced against vein M_1 opposite a forward bend in vein M_2. These all exhibit affinities with the preceding and the next following groups. Even the upward bend of vein M_2 at the stigma is hardly more marked in *Gomphæschna* than in *Phyllopetalia* (fig. 26).

Passing by these two genera, we next come upon a number of others which have a more pronounced Æschnine aspect, as *Boyeria* (Plate XXXVII, fig. 3), *Basiæschna* (Plate XXXVII, fig. 2), and *Hoplonæschna* (Plate XXXVIII, fig. 1). These have vein M_2 more strongly bent toward the stigma, the triangles longer, radial and median supplements well developed, and trigonal supplement and supplementary anal loop developing. In these genera the radial sector is not forked.

In *Æschna* and its nearest allies (Plate XL) we see the further progress of these tendencies. There is this added feature the radial sector has become forked. It will be observed that the anterior branch of this fork is separated from vein M_2 by a single row of cells, and that in the same place in *Basiæschna* (Plate XXXVII, fig. 2) there is a line of cross veins tending to straighten out. The anterior branch of the fork is developed out of this line of cross veins. In the Australian *Æschna brevistyla* (not figured herein) all stages of its completeness and incompleteness may be found in a series of specimens. In the nymphal wing of *Anax junius*, a strong trachea is seen to precede only the posterior branch of the fork. Thus the anterior branch of the fork is clearly a relatively recent acquisition of such genera as *Æschna*, *Gynacantha* and *Anax*, the dominant genera of the subfamily.

In tracing this relatively simple developmental line that leads to the highest specialization of this kind to be found, we have purposely passed by several lateral offshoots. The one of these which seems nearest allied to *Æschna* is represented by *Neuræschna* and *Staurophlebia* (Plate XXXIX, fig. 2), which, having retained the tip of the subcosta which extended beyond the nodus and many cross veins in important spaces, are not to be derived directly from forms in which these have been lost; lacking a brace to the stigma, can not have sprung directly from such genera as those of the Boyeria group in which this useful structure is well developed, but may well have sprung from the common ancestor of *Boyeria* and *Æschna*.

Furthermore, *Anax* (Plate XL, fig. 3), while very highly specialized, has retained the most primitive position of the media at the arculus to be found in the group, and has the hind angle of the hind wing rounded.

and not angulated, in the male. These characters, together wit others found in other organs, give cause for setting apart *Anax* (wit *Hemianax*, Plate XXXVI, fig. 3) as constituting a different develo mental line from the one in which *Æschna* is found.

Then there is the important Brachytron group of genera (*Brach tron* (Plate XXXVIII, fig. 2), *Æschnophlebia* (Plate XXXVIII, fi 3), *Planæschna*, *Caliæschna*, *Nasiæschna* (Plate XXXIX, fig. 1 *Epiæschna*, etc.), which seems at first sight so closely allied to *Æschn* which was set apart by Karsch[a] for systematic purposes, on excelle venational characters, the manner and the purport of whose develo ment remain to be indicated. The radial sector is forked in these, b after the anterior branch is acquired the whole sector does not, a in *Æschna*, bend anteriorly, arching away from the radial suppleme which becomes bent in the opposite direction, but both remain straigh and the tendency seems to be toward strengthening and deepening th fork. As a consequence, vein M_{1a} is allowed in the Brachytron grou to occupy its accustomed place and to bear its share in the stress the wing stroke, not being crowded out, as in the Æschna group, b the encroaching distal end of vein M_2.

Boyeria seems to stand near where was the parting of the ways th led to the development of these two groups. One may see that eith form of radial sector might readily have been derived from that *Boyeria* (Plate XXXVII, fig. 3).

The study of the trigonal supplement adds force to such opinio In *Boyeria* it might be interpreted as joining the median suppleme or as passing below it with a single row of cells between; its positi is not decided. But in the Æschna group it distinctly joins t median supplement, and in the Brachytron group it distinctly exten below by one row of cells.

The behavior of the distal ends of veins M_3 and M_4 offers sti further corroborative testimony. Beginning with a condition li that found in *Boyeria*, where there are several rows of cells includ between these two veins for the distal third or fourth of their lengt the veins themselves being parallel, development takes place alo two distinct lines. In the Brachytron line these veins remain parall and specialization consists in the progressive reduction of the ce between them to a single row. In the Æschna line, vein M_4 becom bent away from vein M_3 at a point opposite the proximal end of t radial supplement, while reduction proceeds as usual on either side th place. (See *Æ. californica*, Plate XL, fig. 1, and *Æ. ingens*, Pla XL, fig. 2.) It will be observed that the vein M_4 finally appears to r into vein M_3. This is wholly due to the increasing deflection of ve M_4 and to the straightening out of two cross veins which happen lie opposite the point of deflection. These cross veins first are

[a] Kritik des Systems der Æschniden, Ent. Nachr., XVII, pp. 273-290.

placed as to cause vein M_4 to appear forked (see *Æ. californica*, Plate XL, fig. 1), when they appear as the upper branch of that fork; finally they appear as the true continuation of the vein. As the anal vein is switched upon the second cubito-anal cross vein in the Libelulidæ, so here vein M_4 is switched into an entirely new position upon two cross veins.

It is worthy of passing remark that this shifting is an accompaniment of differentiation between longitudinal veins in very highly specialized Æschninæ. This will be much more clearly seen in actual wings than in the best of figures. A glance at such wings as those of *Anax junius* or *Æschna californica* will discover that *Rs* is strong, M_2 is weak; M_4 is strong, M_3 is weak; Cu_2 is strong, Cu_1 is weak. The strong vein bounds posteriorly the space in which the weaker one lies. The cross veins just discussed, which join vein M_4 so solidly to vein M_3, together with several lines of cross veins descending from the strongest part of the radial sector, complete the boundary of the space in which the weakest part of vein M_3 is included.

But to return to our theme, we have seen that the behavior of radial sector and supplement, of trigonal supplement, and the distal ends of veins M_3 and M_4 furnish cumulative testimony to two divergent lines of development, which, starting with forms a little less Æschna-like than *Boyeria*, have evolved the groups of *Brachytron* and *Æschna*. And we have shown that, with respect to venation at least, the groups of *Neuræschna*, *Anax*, and *Gomphæschna* are successively more remote.

Gomphinæ.—In this group we come upon another type of Æschnid venation, a type which is chiefly characterized by the similar shifting of the anal vein in both wings, but only to such extent that that vein appears more or less symmetrically forked. There are few venational specialties. Neither the shifting of veins for advantage of position nor the reduction of cross veins have proceeded very far. That venation is at a standstill is indicated by the unusual constancy of mechanically unimportant cross veins, such, for instance, as the one traversing the supertriangle. Variation from the type is slight, considering the large number of genera in the group; and such as there is, it does not lend itself readily to serial arrangement. The very moderately widened anal angle of the hind wing is supported mainly by straight and parallel anal and cubital branches, as in the more generalized Æschninæ. An anal loop is developed in many genera, but has so different aspect in several of them it seems quite possible it may have been developed several times independently. (See *Lanthus*, Plate XXXV, fig. 3; *Cyclophylla*, Plate XXXIV, fig. 1, and *Hagenius*, fig. 23.) A strong trigonal supplement is developed in *Hagenius*. The declined portion of the cubitus (inner side of the triangle) becomes elongated in the fore wing more than in the hind in *Cyclophylla* and *Aphylla* (Plate XXXIII, fig. 3). Accessory sectors of unusual strength

are developed upon the posterior side of veins *Rs* and M_1 in *Gomphidi* (Plate XXXIV, fig. 3). Possibly these features indicate the tips o numerous short developmental twigs. The brief records of the severa parts are certainly contradictory; and the parts themselves, which on might use as bases for the first divisions of the group, seem so nearl of equivalent importance that one may hardly choose between the with assurance. Probably the records of other organs will be mor easy of interpretation.

The South American genus *Agriogomphus* (fig. 27) exhibits vena tional characters that are quite as generalized as are to be found in th group. Triangle and subtriangle are still four-sided, the cubital an anal veins before them being but moderately augulated, the stigma i weakly braced, there is no anal loop and there are no supplements.

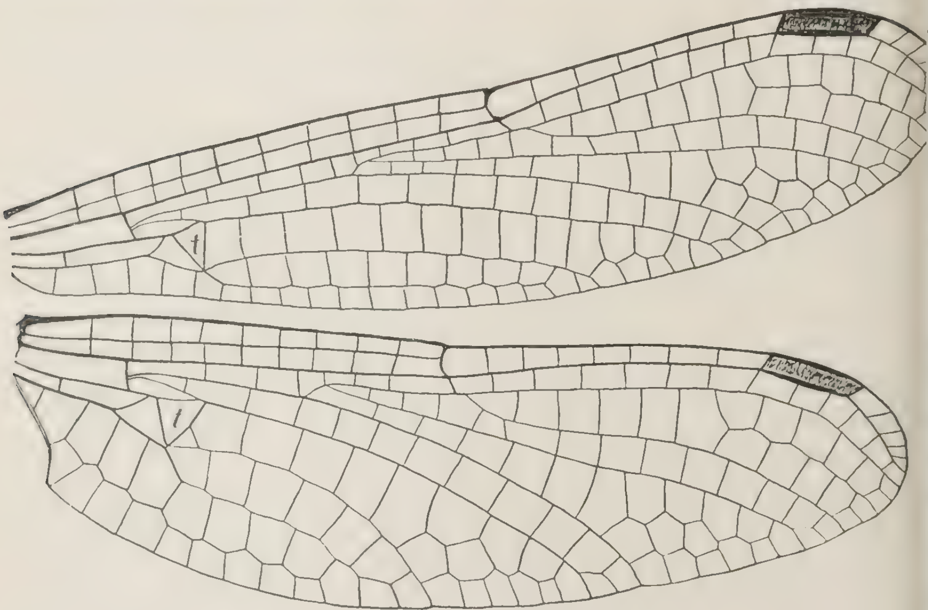


FIG. 27.—WINGS OF *Agriogomphus* SP?

We may remark, in passing, that the Gomphinæ, having attained fair measure of advantageous vein arrangement, and a fair (or, in th strongest species, even a superior) degree of vein differentiation, seen to have turned to a specialization of another sort. The imagoes are o the wing less constantly than other Odonata and fly for a shorter perio During this time their chief concern is with reproduction, hence w find the external genitalia highly specialized. The shortening of th period of imaginal life is correlated, also, with extreme specializatio of the nymph. In fact, the struggle for existence has been mainl transferred to nymphal life.[a]

[a] I have discussed this mattter more at length in my paper, Preliminary studies North American Gomphinæ, Can. Ent., XXIX, 164–168, 1897.

Petalurinæ.—The type of venation presented by this singular group parallels, rather remotely, the Libellulidæ in the behavior of the anal vein, shifting as it does upon the second cubito-anal cross vein to brace the antero-internal angle of the triangle in the fore wing, retaining a more direct course to the hind angle in the hind wing. It parallels the fossil *Stenophlebia* in the curvature of the wing outlines, tending toward a somewhat sickle-shaped wing apex. The very peculiar, narrowly linear stigma is directly correlated with the wing form. It will be observed in the genera *Uropetala* (fig. 4, *s*) and Phenes, in which the costal space is most narrowed and the stigma most curved and elongated, the brace vein has migrated away from the stigma toward the nodus. In this group the anal loop is often not well differentiated (fig. 28). Excepting at the base of the wing, reduction of cross-veins has not been carried very far. *Tachopteryx hageni* (fig. 29) seems to be the most generalized living member of the group (compare with Plate XXXVI, fig. 1). It will be observed this one is most like the Gomphinæ, the subfamily which is doubtless nearest akin. The group is a very small one, apparently on the wane.

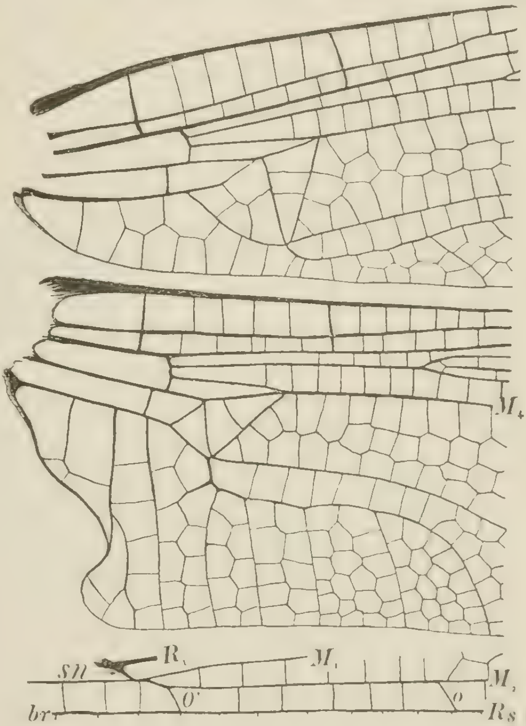


FIG. 28.—BASES OF WINGS OF *Petalura gigantea* LEACH, AND A DETAIL FROM THE REGION OF THE NODUS, SHOWING THE BRIDGE WITH TWO OBLIQUE VEINS, O′ AND O.

It is well represented among the Tertiary fossils of Europe. Of living species there is one in the eastern United States, one in Nevada, one in Japan, and there are several each in Chile and the Australian region.

B. Libellulidæ.—This family, unlike the Æschnidæ, exhibits a single type of venation, whose dominant tendency is toward the differentiation between the wings, by means of the procession of the triangle, and the switching of the anal vein in the fore wing, and in the hind wing the recession of the triangle and the elongation of the anal loop. The stigma is never braced, and the bridge remains shorter than in the Æschnidæ, with fewer included cross veins.

Macromiinæ.—Members of this group (Plate XLI, figs. 1 and 2) have followed these tendencies a little way, and have then gone off on

lines of their own, specializing highly. The shifting of the anal vein in the fore wing, the fusion of the branches of the media beyond the arculus, the development of a strong anal loop (of almost Cordulegasterine form, to be sure), the retraction of the nodus in the hind wing, and especially the general reduction of cross veins and the narrowing of the apex of the wing, mark this as a peculiar group, more distinct than any other within the Libellulid series, and well worthy of subfamily rank.

Libellulinæ, including Cordulinæ, s. str.—Passing *Macromia*, and passing also a few isolated forms with triangles in the fore wing four sided and in the hind wing often little retracted and with the anal loop short, indistinct, or wanting[a] all lateral offshoots, I believe, from near the bottom of the Libellulid series—we come upon a series of closely related forms, the most extensive and flourishing in the order. It were idle to attempt to indicate all the lines of specialization to be

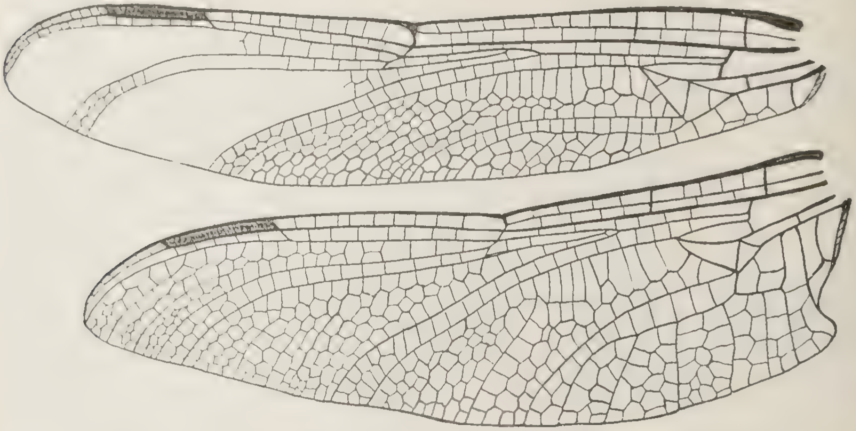


FIG. 29.—WINGS OF *Tachopteryx hageni* SELYS, DETAILS IN PART OMITTED IN FORE WING.

found in the wings of this series. We will endeavor to point out only a few of the leading tendencies that are superadded to the more general ones already noticed.

It is most interesting to note, in this series, how the two venation-evolving processes already discussed, vein adjustment and vein differentiation, have alternately held sway. Thus, in the first instance, vein adjustment has been carried out to a very moderate extent, vein differ-

[a] I pass these by because I have not found the genetic thread that will bind them into a natural series. I have seen but few of them (*Tetrathemis*, fig. 10; *Nannodythemis*, *Nannothemis* (Plate XLIII, fig. 2), *Nannodiplax*, and *Nannophya*), and in this paper we are dealing only with lines of development. These are among the rarest of specimens in collections, and differ so much among themselves that there are of them almost as many genera as species. They have all the earmarks of developmental remnants. If Karsch's group *Nannophyæ* (Ent. Nachr., XV, pp. 245–263) should be made to include all these forms, it should include also *Cordulephya* and perhaps *Idyonyx*, which have more affinity with some of these than with any of the Corduline proper.

entiation to a remarkable extent, and the result has been the evolution of the Corduliinæ, *s. str.* (Plate XLII.) The branches of the media are never extensively fused at their departure from the arculus. The true course of the anal vein behind the triangle is never obscured. The anal loop never becomes distinctly foot shaped. It is short in *Gomphomacromia* (Plate XLIII, fig. 1); longer and shaped like the conventional diagram of a simple gland in *Oxygastra* (Plate XLII, fig. 2), truncated on the end but not widened in *Neocordulia androgynis* (Plate XLII, fig. 1); squarely truncated and slightly widened in the undescribed *Neocordulia* shown in fig. 30; and obliquely truncate and increasingly widened on the "toe" side in *Hemicordulia* (Plate XLII, fig. 3), *Somatochlora*, etc. In short, the vein shifting of the Libellulidæ is far from reaching its maximum in this group, but a fairly

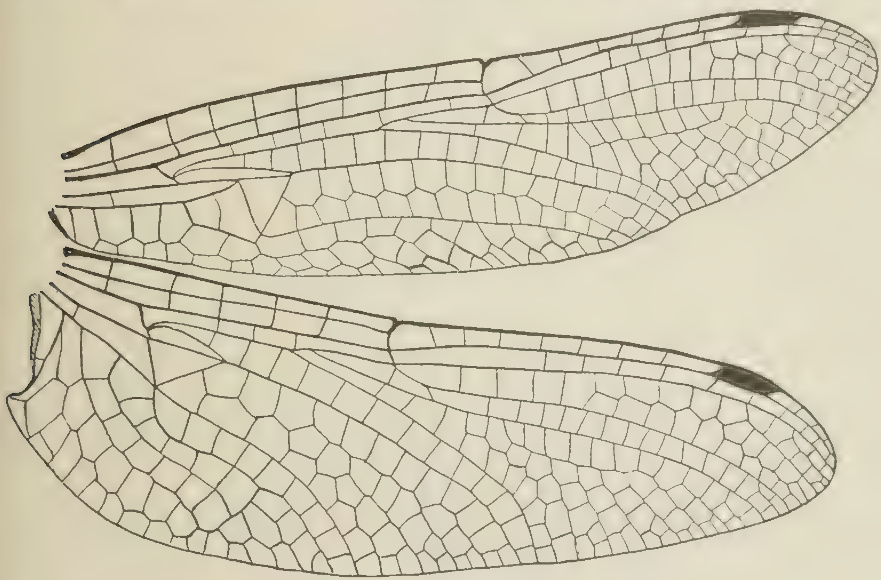


Fig. 30.—Wings of an undescribed species of *Neocordulia* from Brazil.

advantageous arrangement of the veins has been attained, and reduction of unimportant and strengthening of important veins has proceeded until the Corduline wing has become the equal in efficiency of the best of insect wings and the superior of most others in its own family.

Among Libellulinæ proper, *Agrionoptera* and its nearest allies seem, on the whole, about as generalized as any (Plate XLIV, figs. 1–3) in having cubitus and anal vein very moderately angulated before the triangle in the fore wing, slight recession of the triangle and a short anal loop in the hind wing, and in the form of the wing as a whole.

Passing up the series we find the triangles progressing along lines we have already pointed out, the anal loop becoming foot shaped, and extending a support for the ever-widening anal area. When it was just becoming foot shaped, with a rudimentary "toe" meeting the hind

margin of the wing, the hind angle only moderately enlarged, specialization by reduction seems again to have dominated, producing a group of genera of which *Macrothemis* is a good exponent (Plate XLVI, fig. 1).

Then there is the important group of genera allied to *Libellula*, in which the branches of the media at their departure from the arculus are hardly fused, in which the narrowing and transverse elongation of the triangle and the deflection of the anal vein before the triangle have progressed very far, but in which only a very moderate reduction of cross veins has occurred (Plate XLVIII). The tendency of vein M_2 to become undulate is also a feature of this group.

There is also the heterogeneous group of genera allied to *Neurothemis*. These will at least agree in exhibiting the highest degree of vein adjustment together with the lowest degree of vein reduction to be found in the series (fig. 18).

At some point in this series not remote from *Celithemis* (Plate XLVI, fig. 2) may have set in the extensive reduction of cross veins characteristic of a very large number of genera allied to *Sympetrum*. (See Plate XLVI, fig. 3, and Plate XLVII, fig. 1.)

Another offshoot from near the same place, combining in a high degree both kinds of specialization, culminates in *Tramea* and its allies (Plate XLIX), which I regard the most specialized of Libellulinæ, if not of all Odonata.

In the three last-mentioned groups there is a pretty adjustment of the second cross vein in the space between veins M_1 and M_2 in opposition to the proximal end of the radial supplement. Plates XLV and XLVI and fig. 2 of Plate XLVII will show its increasing definiteness and obliquity of position and the perfecting of the brace of which it is a third part, the other parts being the supplement and the oblique vein. A trivial character this? Indeed it is but a straw, yet it shows the way biologic winds blow.

ZYGOPTERA.

In this suborder we have again two families, the more generalized abounding, as before, in venational experiments (if I may so speak), some of which have been abandoned in recent times, the more specialized, being more homogeneous, characterized by a single principal trend in its wing development. The suborder as a whole has retained in recent times two primitive characters, in the similarity of fore and hind wings[a] and in the total lack of supplements.

A. Calopterygidæ. There are four fairly distinct types of venation in this family, the most peculiar of which is represented by the fossil genus *Isophlebia* (fig. 31). In this type the hind wing was as much dilated at the base as in the Anisoptera, but by very different means.

[a] For this reason we figure in most cases but one wing.

The support for the expanded area developed upon vein Cu_2, which was set off from vein Cu_1 by a long posteriorly directed stalk; secondary branches developed upon the posterior side of vein Cu_2 radiating to the wing margin. The anal vein did not join vein Cu_2. The stigma was unbraced, and the wings were decurved at the tips, much as in the Petalurinæ.

Among living Calopterygidæ the tendency has been to match cross veins in lines parallel with the veins, thus producing a large number of interpolated sectors between the principal veins. This has been carried so far that few vestiges of the primitively hexagonal form of the cells remain. This has facilitated (perhaps we should say has accompanied) the throwing of the wing membrane into longitudinal furrows, and we find the sectors, in some forms, alternately convex and concave even to the distal margin of the wing. In those forms in which the furrowing of the membrane is most general we find the least tendency toward reduction of cross veins. Perhaps the fanlike folding of the membrane enabled it to resist bending and rendered unnecessary the differentiation of stronger veins for that purpose.

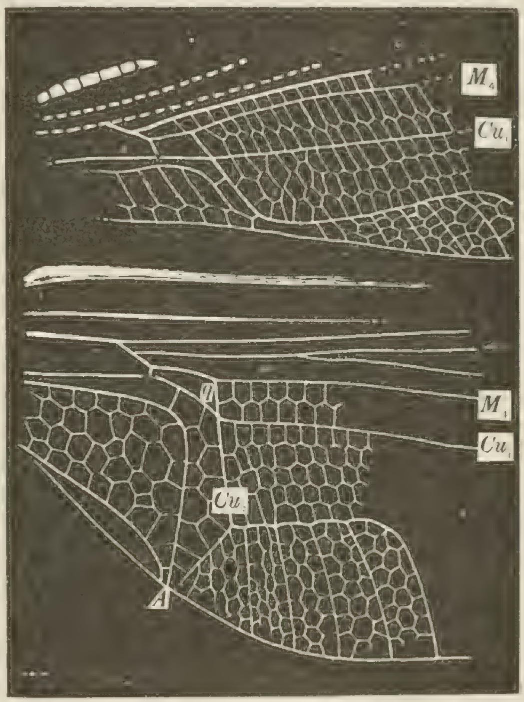


FIG. 31.—BASE OF WINGS OF *Isophlebia* (FOSSIL) IN PART AFTER DEICHMÜLLER.

Epallaginæ.—This group comprises the more generalized living members of the family, especially in the Legion Euphæa of de Selys, wherein the nymphs, so far as known, have paired gill filaments along the sides of the abdomen and have biramous mandibles. In this group the media tends to descend to the middle of the arculus, the nodus to recede moderately toward the base of the wing, and the quadrangle to lose the dividing cross vein. The quadrangle behaves similarly in both fore and hind wings. *Pseudophæa* seems, on the whole, as primitive as any genus of the group (fig. 32). *Rhinocypha* and its allies (Plate LII, figs. 1, 2, and 5) constitute a short lateral series. De Selys long ago showed, from characters not drawn from the wings, that they constitute a distinct subordinate group, but he did not point out the venational characters in which they are peculiar. These will be dis-

covered by observing the behavior of the medial and cubital branches just after their separation. Just beyond the arculus veins M_{1+2} and M_3 separate by arching in opposite directions, forming a symmetrical fork. At the end of the quadrangle vein M_4 arches forward, vein Cu_1 sometimes arching with it, and vein Cu_2 arches backward, the two thus becoming set in opposing positions. Vein Cu_2 remains simple.

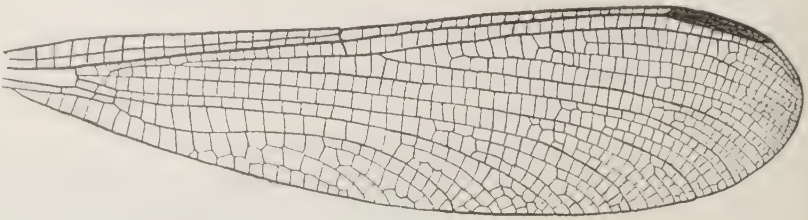


FIG. 32.—WING OF *Pseudophæa sp?*

Throughout the group the stigma is well developed. In the space between veins M_1 and M_2 the longest of the sectors occupies an intermediate position, with shorter sectors on either side of it. The South American *Cyanocharis* (Plate LI, fig. 3) and *Dicterias* parallel the next following group in the fusion of vein M_{1-3} with the radius beyond the arculus, but in general the group is wholly lacking in those peculiar developments that characterize the two next groups.

Anisopleura, *Epallage* (Plate LI, fig. 2), *Bayadera*, *Cyanocharis* (Plate

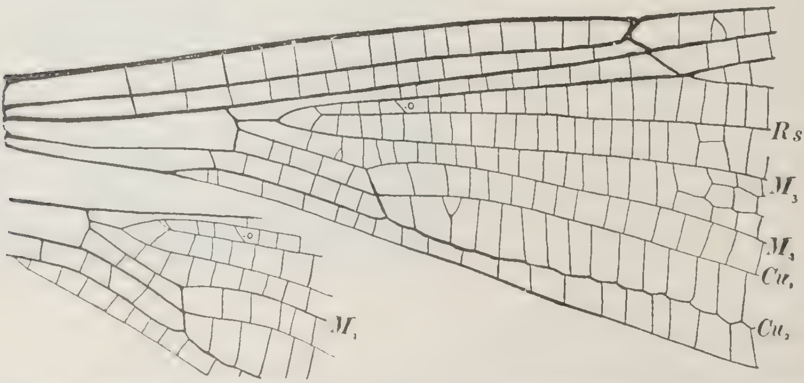


FIG. 33.—BASE OF FOREWING AND A BIT OF HINDWING OF *Rhinocypha sp?* *o*, OBLIQUE VEIN THAT MARKS THE POINT OF SEPARATION OF THE TRACHEA OF THE RADIAL SECTOR.

LI, fig. 3), *Diphlebia*, and *Philoganga* (fig. 44) illustrate a tendency toward the reduction of the base of the wing, and toward a considerable degree of vein differentiation throughout the membrane. The general result is analogous to that arrived at in the Agrioninæ, discussed below.

Vestalina.—In all this extensive group the media descends the arculus and departs from it in a line that is continued directly by vein M_4, while vein M_{1-3} arches strongly from its anterior side. The

fork is thus unilateral. In such genera as *Calopteryx* (fig. 34) and *Vestalis* (fig. 41), vein M_{1+2} reunites with the radius—completely fuses with it—only to separate again, after which its base appears as a cross vein and its distal end as a branch of the radius.[a] The longest of the sectors between veins M_1 and M_2 closely parallels vein M_2, with all the shorter sectors before it. The stigma tends to atrophy, more rapidly in the males. The quadrangle becomes unusually elongated, and is almost always convex on its anterior side and traversed by a number of cross veins, among which the identity of the typical one is never evident. Vein Cu_2, just beyond the quadrangle, sets off a recur-

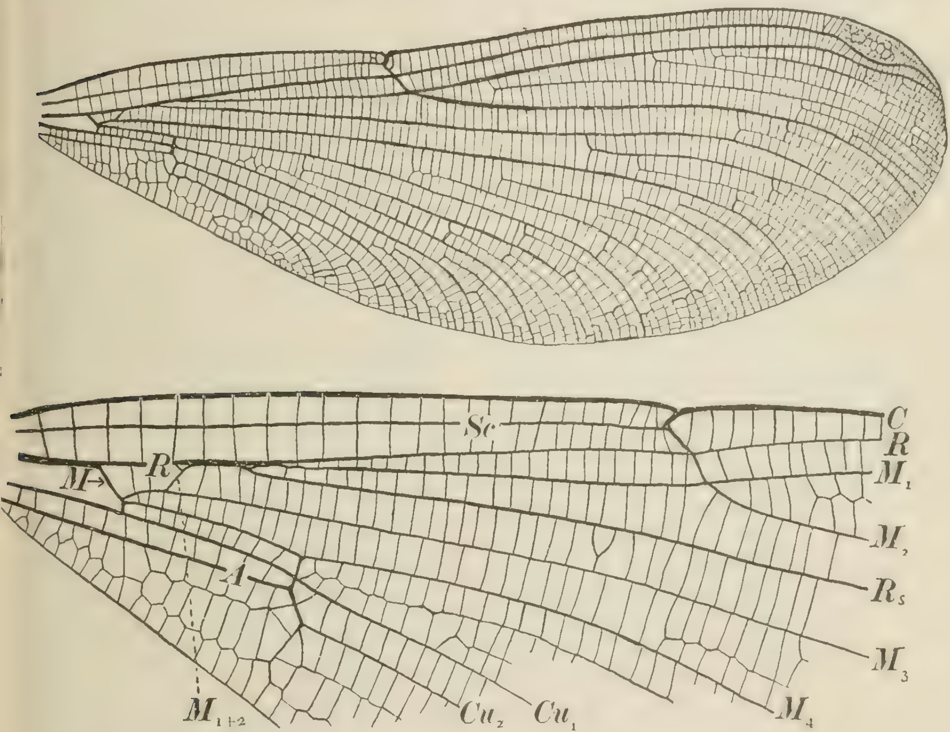


FIG. 34.—*Calopteryx maculata* BEAUVOIS, FORE WING AND BASE OF HIND WING.

rent branch for the support of the anal angle of the wing. The longer interpolated sectors tend to become attached as forks to the front side of the principal veins, and to become set in opposition to the same beyond the point of their attachment. *Vestalis* (fig. 41) illustrates well the culmination of nearly all of these tendencies.

A short side line includes only *Hetaerina* and *Lais*. The tendency in these is neither toward narrowing the wing at the base nor widening it beyond; but it is found evolving a unique transverse wing brace out of the bases of the cubital branches. (Plate LI, fig. 4.)

[a] Thus the radius gained its typical complement of branches, which enabled Redtenbacher to see in *Calopteryx* the form of wing from which all other Odonate wings might be derived! (Ann. k. k. naturhist. Hofmus. Wien, I, 1886, p. 167.)

The main line includes such forms as *Phaon*, *Mnais*, *Calopteryx* (fig. 34), *Neurobasis* (fig. 43), and *Vestalis* (fig. 41), in which the tendency is toward further vein adjustment without much further vein differentiation; attaching sectors to principal veins, and widening the wing distally, losing the stigma.

Thorinæ.—Another type of venation is found in *Thore* (fig. 35) and its allies, a very circumscribed group, comprising but a few South American genera. De Selys long ago set this group apart upon an excellent venational character, i. e., the media does not descend the arculus at all. To this may be added, the media departs from the arculus in line with its branch M_1, while M_3 arches strongly from its posterior side, thus making a unilateral fork which is in position the reverse of that of the Vestalinæ. The longest of the sectors between veins M_1 and M_2 closely parallels vein M_1, with all the shorter sectors behind it. The basal curvature of vein M_4 makes the quadrangle concave anteriorly, and widest at the proximal end. There is an odd differentiation between quadrangles of fore and hind wings, that of the latter becoming twice the length of that of the former. In *Cora* (fig. 36) vein Cu_2 is almost simple; in *Thore*, *Euthore*, and *Chalcopteryx* it is symmetrically forked just beyond the quadrangle.

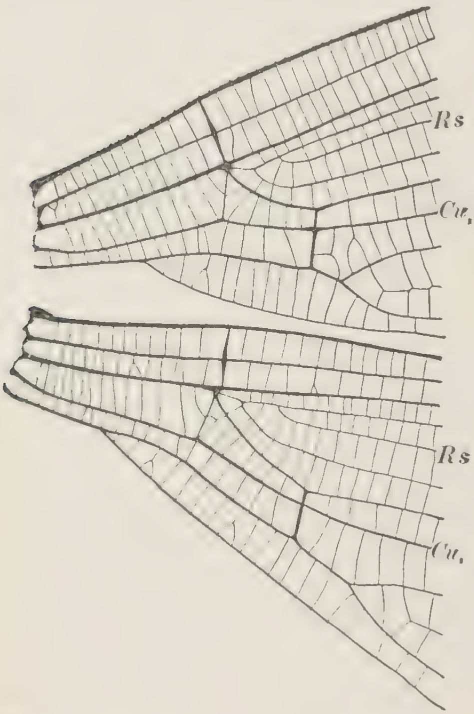


FIG. 35.—BASE OF WINGS OF *Thore gigantea* SEL.

While in this group a form and general aspect of wing much like that of the typical Calopteryginæ has been developed, a comparison of the venational characters will show that the means employed have been almost diametrically opposite.

Some synthetic types. In Plate XLI, fig. 3, there is shown a new figure of the much-discussed *Palæophlebia superstes* Selys, from Japan (fore and hind wing of a female specimen, photo-enlarged. It is by no means easy to indicate the nearest relationship of this isolated species. Wing characters, like other characters, are contradictory. It agrees with the Lestinæ and with the more generalized members of de Selys's heterogeneous and untenable Legion Podagrion in the form of the stigma and arrangement of cross veins behind it, and in the arrangement of the interpolated sectors in the space between veins M_1 and M_2, and also in the obliquely placed quadrangles. It agrees further with Lestinæ in the possession of a long bridge terminated

distally by an oblique vein. It differs utterly, however, in the form of the quadrangle of the hind wing, in the remoteness of the nodus from the arculus, and in the relation of the arculus to the hypertrophied antenodal cross veins.

It agrees with generalized Gomphines in the last-named particular (compare with Plate XXXV, fig. 3), also in the general relations of bridge and oblique vein, and relations between arculus and nodus; but its quadrangles are undivided, and the hind margin of both wings is utterly unlike all known Anisoptera. In having a quadrangle that is obliquely placed, narrowing distally in the fore wing and widening distally in the hind wing and undivided in both, it stands entirely alone.

De Selys pointed out when he described the species that it showed striking resemblance to the fossil genus *Heterophlebia*—a genus, unfortunately, still insufficiently known. The quadrangle of the fore wing is, in fact, practically identical; and other parts of the wing, so far as known (whether there were hypertrophied antenodals is uncertain), are similar. But the quadrangle of the hind wing in *Heterophlebia* is very different. The cubitus, instead of being declined before the

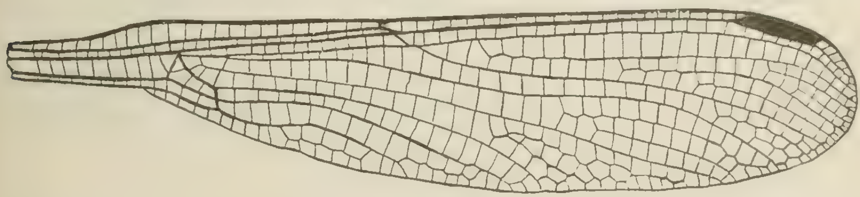


FIG. 36.—HIND WING OF *Cora incana* HAGEN.

quadrangle as in *Palæophlebia*, is bent at the middle of its posterior side, and from that point springs the dividing cross vein, as in Anisoptera; and the cross vein is declined so far that it rests against the upper end of the terminal cross vein of the quadrangle. There is yet another point of difference, of perhaps even greater importance. The bridge at its inner end is directed toward and attached to vein M_3 in *Heterophlebia*, whereas it turns the other way and attaches to vein M_{1+2} in *Palæophlebia* and in all living Odonata. (Although in the more generalized Gomphinæ it is apparently symmetrically forked and not turned either way, whenever the fork happens to be unsymmetrical the leaning is seen to be toward the anterior side.) This is a difference of kind that is not to be passed over lightly.

Heterophlebia shares this peculiarity with one other genus, *Tarsophlebia*, likewise fossil, and it is a strong bond of union between them, of more importance than their rather striking differences, these being mainly differences of degree. *Tarsophlebia*[a] has the quadrangles

[a] *Libellula pannewitziana* Göppert belongs in *Tarsophlebia*, as will be seen by comparing Assman's figure of the type (Zeitschr. für Entomologie, I (n. s.), 1870, pl. I, fig. 11) with fig. 3 of Hagen's plate cited herewith. *Heterophlebia jucunda* Hagen is not a *Heterophlebia* at all, nor even nearly related thereto.

even more obliquely placed, similar in fore and hind wing, without the dividing cross vein, and also without the basal cross vein, so that the quadrangle is confluent with the basal space, much as in the fore wing of fig. 38. The space between veins M_1 and M_2 is narrower also, with a different arrangement of interpolated sectors. These characters are well shown[a] by Dr. Hagen, to whom we owe our best knowledge of these remarkable forms.

B. Agrionidæ.—This family is in essential agreement in all those venational characters which are most fundamental. The tendency throughout is toward extreme reduction of the anal area, making the wing "petiolate," and toward the matching of cross veins in transverse lines. The antenodal cross veins are almost always reduced to two. The nodus is greatly retracted and the quadrangle approximated to it. The media does not descend the arculus.

Lestinæ.—This group is quite unique in its own family in one character that has been already indicated, the radial sector fuses with vein M_3 for a long space, and an oblique vein and a very long bridge, reach-

FIG. 37.—WING OF *Megaloprepus ceruleatus* DRURY.

ing more than halfway from the nodus to the arculus, are preserved. Nodus and quadrangle are but moderately approximated, and the matching of cross veins seems only begun (see Plates LI, figs. 6 and 7, and LIII, fig. 1).

Anormostigmatini.—In this curious group the radial sector leaves vein M_3 at the subnodus, and nodus and quadrangle are quite approximate. The part of the wing beyond the nodus becomes very greatly enlarged. The stigma is never braced; on the other hand, it becomes diffuse or is lost. Cross veins fall into transverse lines over a considerable part of the wing (Plate LI, fig. 8), especially in the smaller species, and interpolated longitudinal sectors in *Megaloprepus* (fig. 37) and *Microstigma* become attached to principal veins, of which they then appear as branches. In the space between veins M_1 and M_2 the longest sector parallels vein M_2. Here the retraction of the nodus toward the base of the wing and the migration of the base of vein M_2 outward toward the stigma have attained their maximum. These are among the most grotesquely specialized of living insects.[b]

[a] Palaeontographica, XV, 1866, pl. II.

[b] Since this paper was written the venation of the genus *Thaumatoneuria* has become known to me through Dr. Calvert's figures (Biol. Centr. Amer., Neur., pl.

Agrioninæ.—This group contains a larger number of genera and species than any other of equal homogeneity of venational characteristics. The radial sector leaves vein M_3 near the nodus (sometimes following vein M_2 in its migration along vein M_1 toward the stigma), and nodus and quadrangle tend to close approximation. Cross veins are generally matched in transverse lines, and the stigma is generally strongly braced.

Two minor lines of development may be briefly indicated in passing: One, tending toward the loss of the branches of the cubitus—*Palaemnema* (Plate LIII, fig. 2), *Platysticta* (Plate LIII, fig. 3), *Disparoneura* (Plate LIV, fig. 2), *Idioneura* (Plate LIV, fig. 3), and *Caenoneura* (Plate LIV, fig. 4); and a second, including nearly the whole of the group which lacked this tendency, but in which nodus and quadrangle become more and more approximate, and the veins M_2, R_s, and M_3 migrate separately along vein M_1 from their accustomed places toward the stigma (Plate LIII, figs. 4, 5, and 6), or in which progress has consisted in

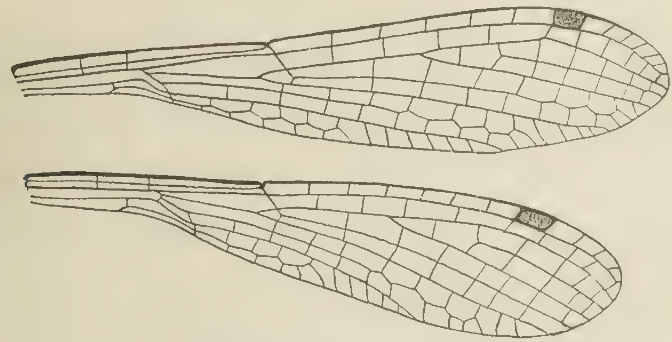


FIG. 38.—WINGS OF *Hemiphlebia mirabilis* SELYS.

mere reduction of cross veins and better matching of them in transverse lines, and in the perfecting braces at the nodus and elsewhere.

This series furnishes in the genus *Hemiphlebia* (fig. 38) a striking example of the loss of a cross vein that is elsewhere very constant—the

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III, figs. 16 and 21). I think *Thaumatoneuria* belongs here; it has all the essential venational characters of this group, and surely these are sufficiently distinctive. It is more generalized than *Megaloprepus*, in that vein M_2 has made less progress along vein M_1 away from the nodus, some vestiges of the primeval extra antenodal cross veins are preserved, most of the interpolated sectors are still unattached to the veins, and the stigma is larger and better preserved. It is a curious and probably significant fact that in the two series of Zygoptera—VESTALINÆ and ANORMOSTIGMATINÆ—in which the long sector between veins M_1 and M_2 parallels M_2 should be the only ones in which the stigma progressively dwindles and disappears. It is conceivable that the stigma might lose importance for want of the support that this sector would give if approximated to it at the apical bend. Perhaps the concavity on the costa in *Mecistogaster lucretia* (Plate LI, fig. 8) and the conjoining and the sharp bending backward of the veins behind it may be a unique way of supplying such deficiency of bracing, preserving the utility of the stigma as a weighted striking point toward the end of the cutting edge of the wing.

cross vein forming the lower end of the arculus.[a] This is entirel absent from the fore wing of the males; it is present, however, in th hind wing of both sexes, and often also in the fore wing of the femal The loss of this cross vein has resulted from a shift of other veins an a consequent shift of responsibility in stress of wing stroke. Th symmetrical fork formed at the separation of veins M_{1+2} and M_3 (els where always unilateral unless the fork be very narrow) and the upwar bend of the anal vein at its departure from the hind margin, to mee the cubito-anal cross vein and the very considerable progression of th arculus beyond the second antenodal, are the visible signs of the rea justment which has relieved the basal side of the quadrangle of i former responsibility.

It is needless to remark after observing the form of the wings, th among the Zygoptera there are no strong flying species. Most o them fly so low over the surface of the water that their winge enemies can not safely descend to their level. The Lestinæ live ami sheltering semiaquatic vegetation. Vestalinæ seem not to be desir for food; their coloring may suggest that they are not good eatin The action of the wings is that of sculling solely; only the distal po tion of the wing which takes the active part in insects' flight is we developed. There is no soaring basal aeroplane, as in the Anisopter to support the body passively by merely gliding upon the resistant ai

I offer below a scheme of subfamilies for the order, which seems t me to be, in the light of the evidence that present knowledge of ven tion affords, an approximation toward equivalent values for the groups. The weakest distinction seems to me to be between the Co dulinæ and the Libellulinæ; the most doubtful association of rece forms that of *Cordulegaster* and *Petalia* together. The fossil grou seem not only more isolated but also more strongly characteriz structurally than the others.

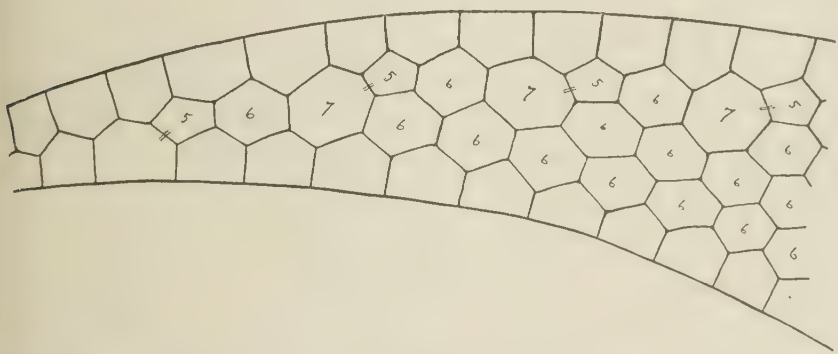
Anisoptera.	Æschnidæ.	1. *Gomphinæ* (recent and fossil).
		2. *Petalurinæ* (recent and fossil).
		3. *Stenophlebinæ* (fossil).
		4. *Cordulegasterinæ* (recent and fossil).
		5. *Chlorogomphinæ* (recent).
		6. *Æschninæ* (recent and fossil).
		7. *Æschnidiinæ* (fossil).
	Libellulidæ.	8. *Macromiinæ* (recent).
		9. *Cordulinæ* (recent and fossil).
		10. *Libellulinæ* (recent and fossil).
Zygoptera.	Calopterygidæ.	11. *Heterophlebinæ* (fossil).
		12. *Palæophlebinæ* (recent).
		13. *Epallaginæ* (recent and fossil).
		14. *Vestalinæ* (recent).
		15. *Thorinæ* (recent).
	Agrionidæ.	16. *Lestinæ* (recent and fossil).
		17. *Agrioninæ* (recent and fossil).

[a] This arculus cross vein is absent in the fossil genus Tarsophlebia as already note

V. DYNAMIC CONTROL IN VEIN EVOLUTION.

So numerous are the evidences that veins are largely controlled in heir development by purely mechanical causes, it would be impossible, vere it not also undesirable, to enumerate them here. We have come pon parallelisms at every turn. We have seen essentially the same aechanical feature of efficient wings made out of homologically diferent things repeatedly. But the adult wing is only a machine, and his was to have been expected. It remains now for us to notice a few eatures which indicate the operation in these wings of far-reaching nechanical principles.

It is not at all surprising that we should find the first regular form aken on by the areoles of the wing to be hexagonal. The hexagon is ature's favorite plane figure, and there is a good mathematical reason vhy it should be so: economy is a good biological reason. We have



IG. 39.—DIAGRAM ILLUSTRATING A TYPICAL (HYPOTHETICAL) ARRANGEMENT OF THE AEROLES IN ONE OF THE WIDER SPACES OF THE WING.

lready shown that bordering, straight veins eliminate certain angles f the hexagons, converting them into pentagons and rectangles. We ass now to notice the arrangement of the areoles in the wider areas f the wing, where least influenced by the veins. The spaces between rincipal veins or branches of veins, widening distally, are filled proxmally by a single row of rectangles or by a double row of alternating entagons. Actual hexagons are present only when there are three or nore rows of areoles included. The first cell in each added row is ypically a pentagon, which presents an angle to the cleft between the eparating rows of areoles and a straight side to meet succeeding hexagons. A triangle or a heptagon would of course do the same, but ot with so little disturbance of surrounding hexagons. Opposite the nitial pentagon an areole in one of the preexisting rows acquires an dditional side, becoming a heptagon (or a hexagon, of course, if it vere first a pentagon). Thus pentagon and heptagon are complemental, nd together initiate new rows of cells with the least possible disturb

ance of the series of hexagons. The accompanying diagram (fig. 39 shows the ideal cell arrangement.[a]

I hasten now to add that a perfectly typical arrangement of th areoles throughout a single entire space in a dragon-fly wing I hav not found, although it is easy to find in many of the more generalize forms ample evidence of the operatio of the principle. The accompanyin drawing (fig. 40) of parts of actua wings will serve for illustration. have made no hunt for better, for thes show, also, why the typical conditio is so early lost. Accessory trachea branches penetrate along broken line of cross veins, bringing them into line then supplements are superadded, an the havoc of the hexagons is complete Enough of the typical arrangement fo recognition is to be looked for only i wings lacking strong accessory trachea branches and supplements.

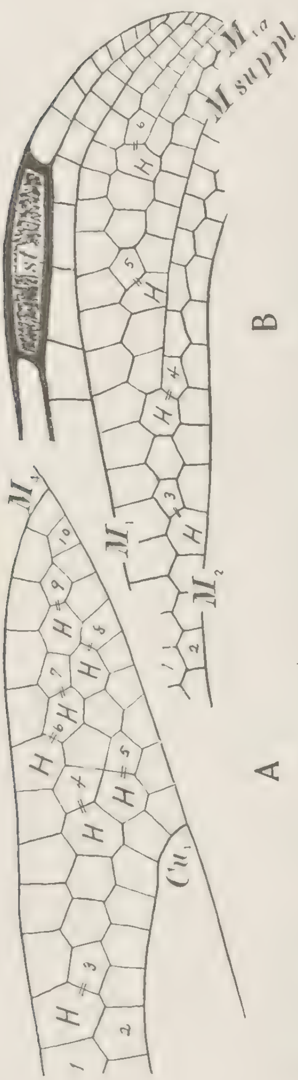


FIG. 40.—DRAWING OF PARTS OF WINGS, SHOWING THE ACTUAL CELL ARRANGEMENT. *A. Epigomphus paludosus; B. Agrionoptera insignis.* INITIAL CELLS ARE NUMBERED IN THE ORDER OF THE INTRODUCTION OF THEIR SEVERAL ROWS; HEPTAGONS ARE MARKED WITH AN H.

Tissue cells often appear hexagona in section, and when crowded into sim ilarly shaped areas, often behave a do these areoles of dragon-flies' wings The histologist who looks over the plate accompanying this paper will not fa to see here and there groups of areole showing conformation entirely compa able to familiar images of tissue cells

Coming now to some points whic have to do probably only with wing and with aerial navigation, we reca that a form of wing broad at base an narrow and pointed at the apex, we known for its efficiency in insects ge erally, we have seen developed twic upon two very different plans, culm nating in *Anax* and *Tramea* respectively. Both have adjusted th wing apex to a degree of rigidity on the costal margin, and of plian behind it, which gives the greatest resultant in forward motion fo

[a] Dr. R. T. Jackson has shown (Bull. Geol. Soc. Amer., VIII, 1896, p. 164) that t interambulacral plates of sea urchins are potential hexagons, that the border ro are pentagons—hexagons, with one angle eliminated, as here—and that pentagon a heptagon together initiate new rows of plates. Practically the only difference betwe the typical arrangement of these areoles and that of the interambulacral plates, figured by Dr. Jackson, arises out of the difference in the shape of the areas to be occ

rapid vibration in air. Both have developed at the wing base close against the body a broad soaring surface, an aero-plane, which in rapid flight supports the weight of the body upon the resistant air. Wings of broad base and pointed apex are characteristic of other insects of rapid flight, but in most others (hawk moths, cicadas, bees, etc.) the two wings are united and used as one. The basal expanse is secured by shortening the hind wing and directing it posteriorly. Different as are the wings of birds, these also are sharply pointed in the species of swiftest flight (ducks, swallows, etc.). I can not state the aeronautic principle involved in the pointed wing, but I ask no better proof of its existence than is furnished by the efficiency of such a wing and its repeated independent development.

In the arrangement of the principal veins we have called attention to the fact that the Odonata, except in the earliest stages, differ very widely from all other insects. There is hardly a group from which they differ more in fundamental plan than the Ascalaphidæ. The latter

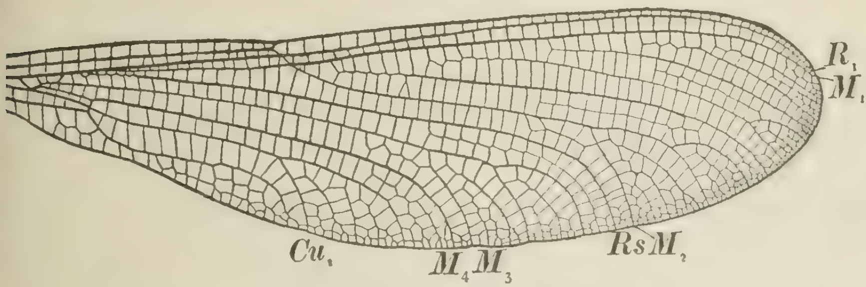


FIG. 41.—WING OF *Vestalis amoena* SELYS.

have the radial sector enormously developed and in its accustomed place, occupying the central field of the wing, while the media is greatly reduced; in the Odonata the development of these parts is reversed and the radial sector is out of place. The differences at the costal border of the wings is so great that I will only invite comparison of the Ascalaphid wing in Plate XXXVI, fig. 2, with the wing of any dragon-fly. If now, without reference to homologies, we examine this wing of *Ulula*, we will see in it familiar mechanical features. (1) From the stigma there extends obliquely across the wing tip to the posterior margin a vein which occupies the position, and probably performs the function, of the vein M_{1a} in the Odonata. (2) Intersecting the wing obliquely, so as to mark off a basal posterior third

pied in the two cases. In the echinoderm the area is symmetrical, and new rows are introduced alternately on the two sides. In the dragon-fly wing the space is unilateral, as shown in the diagram, and the rows are introduced chiefly upon the anterior, convex side. The principle is the same; but we should not omit to notice how different are the two things whose arrangement it controls—in the one case, solid plates; in the other, a mere rim of solid matter surrounding an almost empty space.

of it, are two parallel veins, separated by a single row of cells, analogous to the veins M_3 and M_4 in the Odonata. (3) Behind these is a transverse bracing of the basal part of the wing, analogous to the triangle in the Anisoptera, and to the special braces beyond the quadrangle in *Lais* and *Hetærina*.

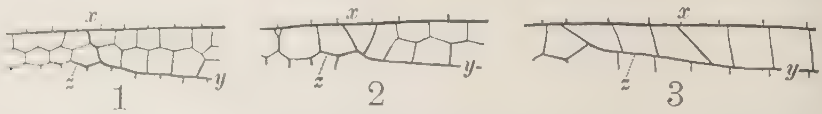


FIG. 42.—DIAGRAM (HYPOTHETICAL) OF THE EVOLYTION OF A BRACE FOR A UNILATERAL FORK; 1, 2, 3, SUCCESSIVE STAGES.

We have shown that the brace vein to the stigma and the supplements, etc., are independently developed in several groups. We have shown that the sectors interpolated between the tips of veins in several groups have become attached to veins, making the latter appear forked. Our illustrations of this were veins *Rs* in the Aeschninæ, and veins M_2 and M_1 in *Chalcopteryx* (fig. 22); but if one wishes to see how far

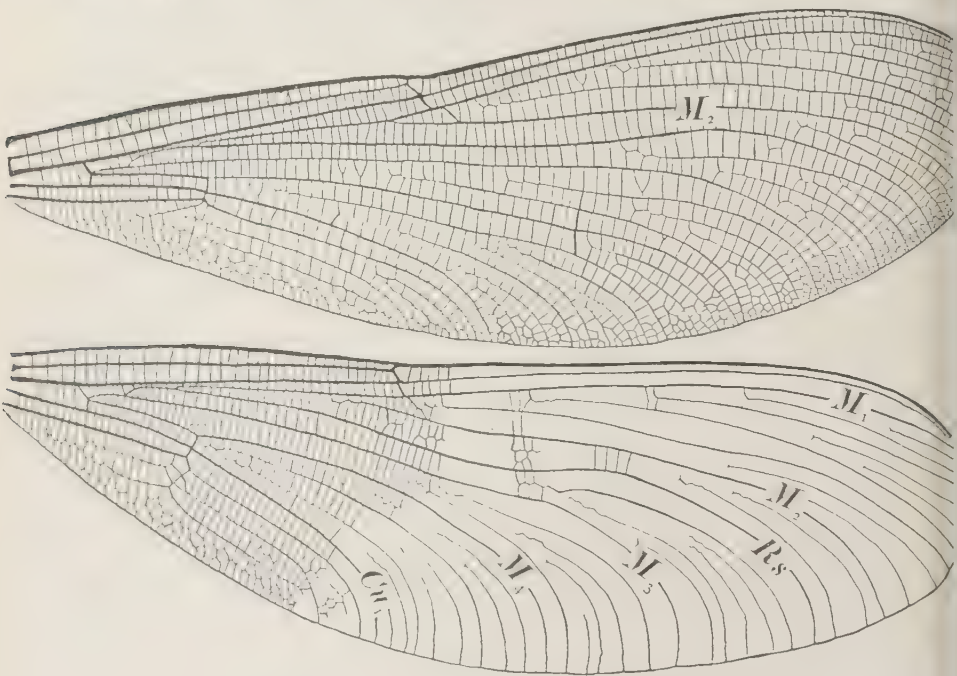


FIG. 43.—WINGS OF *Neurobasis kaupii* BRAUER.

this process has been carried on independent lines, let him examine such wings as those of *Megaloprepus* (fig. 37) and *Vestalis* (fig. 41).

There is one frequent tendency toward purely mechanical improvement of which we have given but a single example—the bridge, joining the radial sector to vein M_{1+2}. It is manifest always in a brace of the same kind as the one which we have technically designated as the bridge, and is formed at a point where a branch springs from the side of a straight vein and then bends parallel. The accompanying diagram

(fig. 42) shows how such a brace is evolved out of the boundaries of ordinary cells.

This brace joins the main vein with the elbow in the branch, thus correcting the mechanical weakness of the unilateral fork. Aside from the bridge, such a brace is developed in *Rhinocypha* (fig. 33), extending the attachment of vein *Rs* along vein M_{1+2} toward the arculus;[a] also, in *Chalcopteryx* and many Calopteryginæ; again, at the proximal end of vein M_2 in *Neurobasis* (fig. 43) and a few closely related genera,[b] as it was, also, in some fossil species referred to *Stenophlebia;* again, at the proximal end of vein M_{1a} in *Nasiaeschna pentacantha* (Plate XXXIX, fig. 1) and many other Anisoptera, in which, however, it is, as a rule, imperfectly developed or not developed at all; and again in *Philoganga montana* (fig. 44). The bridge itself seems to be still extending proximally in some Lestinæ (Plate LI, figs. 6 and 7, and LIII, fig. 1), its slender proximal end being often unattached to vein M_{1+2}.

Here we have strong side light upon the early history of that most distinctive peculiarity of dragonfly wings, the crossing of the radial

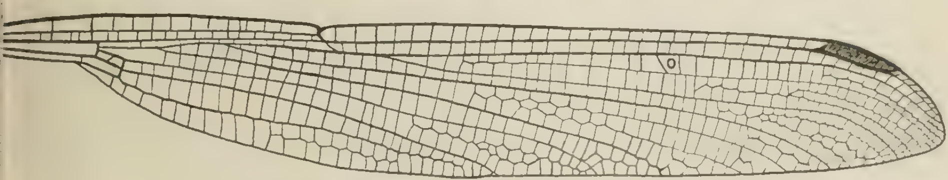


FIG. 44.—WING OF *Philoganga montana* SELYS.

sector over two branches of the media and the development of the bridge. Why this crossing should ever have taken place is left entirely unexplained. That it was established very early in the history of the group is indicated by its occurrence in very early nymphal life, crossing being no longer possible after the internal fusion of the hypoderm cells to form the tracheal channels. But, once across, it formed a weak unilateral fork upon the posterior side of vein M_2, while occupying a field where strong developments were possible. Hence a strong bridge was evolved for its support, and the development of the bridge doubtless followed the lines we have just indicated. The proximal end of the bridge in most living species joins vein M_{1+2} directly, but in most Gomphinæ it appears as if forked, and in the fossil Heterophlebinæ it joined vein M_3 directly.

In the singularly isolated fossil genus *Stenophlebia*, whose venation has been figured in a very detailed manner by Hagen,[c] there is a con-

[a] It will be remembered that the trachea *Rs* here springs directly from trachea M_{1+2}. The oblique vein (o', fig. 34) marks the place of its origin; on the proximal side is the added brace (br').

[b] It will be observed that this brace is better developed in the fore wing than in the hind in *Neurobasis;* similarly, the other brace just mentioned for *Chalcopteryx;* two further examples, therefore, of unequal development of fore and hind wings.

[c] Palæontographica, XV, pl. III, fig. 1.

dition of the crossing of the radial sector so curious one hesitates at attempting to explain it on the ground of published figures that were drawn without ontogeny in mind. It looks as if, a little beyond the nodus, the radial sector had crossed over but one branch of the media and had then developed a short supporting bridge; as if a stage a little less primitive than that shown for tracheæ in fig. 1, *B*, had been the permanent condition in this genus. But perhaps the interpretation of homologies given by Hagen is correct (naturally it is the only one that would occur to him), in which case the bridge is developed as a support to vein M_2, and the radial sector is shifted proximally at its base—a very curious state of things for Anisoptera! And *Stenophlebia* is distinctly anisopterous, notwithstanding its lack of differentiation between fore and hind wing. Aside from the characters just discussed, it is a very curious form in its sickle-shaped wing tips, its dislocated nodus with the subcosta descending upon the radius, its undifferentiated subtriangles, its triangles transversely placed in both fore and hind wings, and its remarkably developed trigonal supplements.

If I mistake not, it is to the readjustment of stress after the crossing of the radial sector that is due the curious bendings of veins M_3 and M_4 in many fossils (notably in *Cymatophlebia*), in some living forms of ancient aspect (*Phyllopetalia*, fig. 26, and *Chlorogomphus*, fig. 24, etc.), and in some of the more generalized members of groups at present dominant (*Gomphaeschna*, Plate XXXVII, fig. 1; *Didymops*, Plate XLI, fig. 2, etc.). This bending is very different from the undulation of the radial sector in certain Libellulinae. This is primitive, defective, and early disappears in the dominant groups, or becomes transformed into something very different and more useful. That other is recent, local, and is but one among several factors in the bracing of the wing area in which it occurs.

When vein *Cu* became unilateral on its posterior side, the weakness of this fork was corrected by the apposition of the distal end of vein A_1.[a]

It must be borne in mind that dynamic control in vein development, dynamic genesis, or whatever we call it, may be but the result of the natural elimination or subordination of those variations which do not tend toward the mechanical perfecting of the machinery of flight.

VI. SUMMARY AND CONCLUSIONS.

1. In the course of this study I have come upon numerous manifestations of developmental dynamics:

(*a*) I have shown the operation in dragon-fly wings of far-reaching

[a] This type of bracing, which is so confusing of homologies as generally to require ontogenetic study for their unraveling, is of very common occurrence near the apex of grasshopper wings.

mechanical principles, in accordance with which the potentially hexagonal areoles of the wing are arranged in the spaces they must occupy, as are other wholly unrelated potentially hexagonal structures in other organisms.

(*b*) I have shown that there is developed in this group, several times independently, a form of wing that is elsewhere most efficient—a wing broad at base and long and pointed at the apex, rigid at the front and pliant toward the rear margin—a wing combining the principle of the aeroplane with that of the scull.

(*c*) I have shown that the development of wing braces follows strictly mechanical principles, analogous braces being repeatedly developed out of homologically different parts. Many examples have been cited within the order, and one without, in the comparison of Odonate and Ascalaphid wings.

2. In this study I have indicated processes concerned with the development of these wings which will probably be found affecting the evolution of insect wings in general:

(*a*) I have shown that there are two kinds of specialization in operation throughout the order—vein shifting, concerned with securing advantageous position of the parts, and vein differentiation, concerned with the strengthening of the most important veins by an economical use of all strength-giving wing material. The former alone seems to have been made use of in venational studies hitherto; the latter is often a more sure criterion of the degree of specialization.

(*b*) I have offered a hypothetical explanation of the progressive differentiation between veins and membrane.

3. In the study of dragon-fly wing venation only the comparative anatomy of the adult wings has been drawn upon hitherto. I have added the ontogenetic method, beginning my study of the veins with that of their antecedent tracheæ. I have found this method to furnish most satisfactory evidence as to what was the primitive position of the veins in almost every part of the wing for all the principal groups of the Odonata. This, followed by careful study of adult wings, both recent and fossil, has enabled me to make some slight contributions to Odonatology proper:

(*a*) I have for the first time homologized in detail the parts of the dragonfly wing with those of the wings of insects of other orders, applying the simple Redtenbacher terminology, retaining the special terms already in use for parts not represented in other orders, simplifying some of them, and adding a few new terms for parts not hitherto designated by name.

(*b*) Homologies within the order have been pretty well understood for a long time, thanks to the labors of many able entomologists, among whom may be mentioned Hagen, Walsh, and especially that lifelong student of this order, Baron de Selys Longchamps. In 1893,

Calvert[a] critically reviewed and correctly stated the matter, adding some results of his own. I have been able to extend the study of homologies in a few parts, such as the region of the bridge, the supplements, the anal area, and several spaces in which special bracings occur. In these places occur the most distinctive venational features of the smaller groups.

(*c*) Incidentally, I have shown something of the relative values of the different characters that have been used hitherto to distinguish groups. Characters drawn from the form and position of the arculus and triangle and other strong braces have always proved reliable, but it is very clear that antenodal and other cross veins have been greatly overvalued, and it is equally clear that many other more important venational characters have not been noted. It is not the presence or absence of weak cross veins, but the position and relations of those that strongly brace the wing; not the number of rows of areoles that may fill a wide area, but the course of principal veins and of their supporting sectors, that are of first importance.

(*d*) I have been able to indicate many new minor lines of specialization within the order, and to add new and corroborative evidence to some lines already indicated by Kolbe, Karsch, and Calvert. Owing to the presence in these wings of a number of characters which may vary independently, for each of which primitive conditions are easily determined, and in each of which the several courses of specialization are easily traced, I have often been able to put forth conclusions based on the cumulative testimony of several parts. I have attempted to find such genealogic evidence as is preserved—not to create any—and have been content to drop, without any suggestion that might hinder future studies, cases in which evidence from wings alone seemed insufficient. But I have not hesitated to indicate relationships when these seemed well evidenced by the facts of venation.

4. Following my morphological study of the order with a review of its members, as distributed among the several families and genera, I mention some facts which might themselves serve independently as biological indications of specialization:

(*a*) A large group of closely related species, numerically dominant in its proper range, indicates the culmination of some type of specialization. This may affect either the nymph or the adult or both.

(*b*) Small and scattered genera, which include only the more rare and delicate species, are pretty apt to be the conservators of numerous generalized characters. However, since development has not stood still with any species, certain marks of specialization will also always appear.

[a] Trans. Amer. Ent. Soc., XX, pp. 162–169. The papers therein discussed, together with the few referred to in footnotes to these pages, constitute the whole of the useful literature of Odonate venation, hence no bibliographic list is hereto appended.

(*e*) Set apart from any group its dominant forms and there will remain those members of it which most closely ally the group with its neighbors.

5. What of genealogies based on external characters?

In this paper we have been dealing almost entirely with external characters—superficial characters, viewed from the standpoint of the physiologist. But hard parts, though dead, are the enduring mold in which the living being is cast, and represent the outcome of its struggle with environment. Therefore we may make more use of the principle of natural selection than is usually possible in the ordinary morphological work, having frequent recourse to the almost axiomatic principle that "useful structures once acquired will not be lost (other things being equal) in a single series, unless replaced by more advantageous structures." This is but a partial paraphrase of the more usual statement of the principle of natural selection, which may itself be condensed into three words—utility determines survival.

In order to apply this principle, we have, therefore, to know that the structures whose development we are tracing are useful structures. The proof of their utility may be derived from various sources. Take, for illustration, the brace to the stigma, which, we have seen, is developed from an ordinary cross vein:

(*a*) Its efficiency may be demonstrated mechanically. This I have not done, though it would not be difficult.

(*b*) It may be demonstrated experimentally. This I have done (on Agrioninæ) by cutting out a little piece of the brace in each wing and noting the resulting weakening of flight.

(*c*) It is demonstrated biologically by the success in life of those forms which possess the brace. They are the dominant members of their respective groups, being in numbers of species and of individuals vastly in the majority. With creatures absolutely dependent on their wings in mating, in feeding, and in escaping their enemies, this is ample demonstration of the efficiency of the wings as a whole, and, incidentally, of each part that is found here better developed than in the less successful members of the series. While this proof is less specific, while one may not learn from it the contribution any one structure has made to the excellence of the wing as a whole, it is the real proof after all.

(*d*) I ask no better proof of the efficiency of any structure than is furnished by its repeated independent development in those forms which are acknowledged to be the most specialized members of the several groups.

By these means we may arrive at some knowledge of the efficiency even of structures about whose use we know so little as we do of the several parts of the insect's wing.

The application of the principle above stated furnishes the means

for critical determination of the course of specialization. For instance, forms with unbraced stigma are not to be derived directly from other forms which have the stigma braced; and so for every other useful structure; and so for every stage in the development of each. When the records of the several parts (or of the several organs) agree, the arrangement of forms is simple enough. When they conflict—when one form is specialized in this character and the other in that—we are dealing with different lines of development, and the group is to be divided on the most ancient or fundamental character concerned. When a number of characters in disagreement seem of equal importance, with no preponderance of evidence in favor of any one as a basis for a first division, only a tentative arrangement of the groups, subject to change after study of other parts (or organs), is possible. Even when a number of characters are studied and all are in accord, and a small group may be arranged with confidence, evidence from additional parts or organs may show the group to be somewhat less homogeneous than it at first appeared. It is obvious that in a genealogic study that organ or part is most valuable which possesses the largest number of characters of which one may be sure he knows both primitive form and secondary conditions and characters, which may vary independently.

It is probable that every single functional organ exhibits developmental features that are characteristic of even the smallest groups, and that the true record of relationships is preserved in every organ if we could but read it. While a classification based upon a single organ is necessarily incomplete, the necessity for the incompleteness arises out of our inability to interpret or even to see the significant features. While a classification based on one organ is necessarily incomplete, it is not necessarily incorrect. It will at least be self-evident that the classification which must prevail because it expresses the concurrent record of all the parts will be hastened by the serious and careful study of each character singly, to determine the facts of its origin, development, and utility, and to trace these facts to their logical and necessary conclusions.

6. This is only a beginning of what should be done in the study of the venation of the order. The distinctive group characters need to be known, not for whole wings alone, but for every part of the wings. The results worked out in this paper are not specific enough to meet at least three immediate, practical needs. It is frequently necessary to determine fragments of wings:

(*a*) In food studies.

(*b*) In the study of unknown nymphs, whose developing wings contain the full outline of the venation of the imago. Such wings are often imperfectly preserved and are to be removed only in fragments. Their correct determination makes the most exacting demands on one's knowledge of venation.

(*c*) In the study of fossils, that are oftener fragmentary than otherwise and that present no other characters so well preserved. From the standpoint of pure science, the need of better knowledge is greatest here. The present systematic arrangement of the known fossil Odonata is a miserable jumble, and some statements that have been drawn from it in a number of books and papers on geographic distribution are quite misleading. Instances have already been cited of fossil forms that are referred to the wrong suborder. There have been some greater and many lesser unnecessary errors of reference. *Libellulium kaupii* Westwood is probably not a dragonfly at all, while *Hemerobioides giganteus* Buckman is a dragonfly of the subfamily *Isophlebinæ* (as may be seen by comparing Buckman's figure with the forewing of fig. 31), and not a huge hemerobian, as has been supposed. *Libellulium agrias* Westwood belongs in the Æschnidæ, being in every detail that Westwood figured diametrically opposed to Libellulidæ. *Libellulium antiquum* Brodie belongs in the Æschnidiinæ, and so also does the *Æschna flindersiensis* Woodward. The only fossil Æschna that seems to fit that name in the modern sense of it is *Æ. solida* Scudder. *Æschna separata* Scudder and *Æschna metis* Heer, especially the latter, which was improperly removed to *Anax* by Hagen, will go in *Hoplonæschna*. *Æschna perampla* Brodie and *Æschna hageni* Heer, judged by poor figures, will hardly go in the Æschninæ. *Stenogomphus carletoni* Scudder,[a] which was independently determined by the two most distinguished students of the Odonata, de Selys and Hagen, to be nearest *Gomphoides stigmatus* (Plate XXXIII, fig. 2) among living forms, and which stands as the only known American fossil Gomphine, is in fact a Libellulid in every line, and had the hind wing been preserved no one would have thought it a Gomphine.

While it would be manifestly impossible, owing to defective preservation, to refer fossils, in most cases, to genera of such thin cleavage as modern practice allows for recent species, it is very obvious that a new study of the types of the older authors would help much toward a better arrangement of our system. New figures of these are especially needed. Mr. Scudder's figures are the only ones that I have found entirely reliable. All others show omissions or alterations of unnoticed characters of critical importance. For instance, the oblique vein, even in Hagen's drawings, is rarely shown. This is not surprising, so long as it was regarded merely as one of a row of cross veins; but it is disconcerting in a study made from the ontogenetic standpoint. When the structural characters that are actually preserved by fossils already in collections have been fully interpreted, we shall know much more concerning the history of the group. Generalisations can not safely proceed faster than the development of real knowledge.

[a] Bull. 93, U. S. Geol. Surv., pp. 12–15, pl. 1, fig. 1.

EXPLANATION OF PLATES.

Plate XXXI. Nymphal wings (photomicrographs).

Fig. 1. Wings of *Gomphus descriptus* Banks, nymph full grown.
2. Wing of *Lestes rectangularis* Say, grown nymph, showing the radial sector attached to the median trachea.
3. Portion of hind wing of young nymph of *Anax junius* Drury, previous to the development of any veins, showing the first indications of bridge, triangle and anal loop.

Plate XXXII. Nymphal wings (photomicrographs).

Fig. 1. Small portion of wing of a nearly grown nymph of *Anax junius* Drury, with veins developing, showing the formation of the radial supplement (*R. suppl.*) and of the brace vein between veins M_3 and M_4.
2. The basal part of the fore wing of a nymph of *Lanthus parvulus* Selys, showing the formation of the arculus and the triangles.
3. The nodal region of the same wing, showing the formation of the bridge and the oblique vein.

Plate XXXIII.

Fig. 1. Wings of *Gomphus dilatatus* Rambur.
2. Wings of *Gomphoides stigmatus* Say.
3. Wings of *Aphylla producta* Selys.

Plate XXXIV.

Fig. 1. Wings of *Cyclophylla diphylla* Selys.
2. Wings of *Progomphus obscurus* Rambur.
3. Wings of *Gomphidia* sp?

Plate XXXV.

Fig. 1. Wings of *Gomphus vulgatissimus* Linnæus.
2. Wings of *Hemigomphus ochraceus* Selys.
3. Wings of *Lanthus parvulus* Selys.

Plate XXXVI.

Fig. 1. Wings of *Tachopteryx thoreyi* Selys.
2. Wings of *Ulula sp ?* (from Brazil).
3. Hind wing of *Hemianax ephippiger* Burmeister.

Plate XXXVII.

Fig. 1. Wings of *Gomphæschna furcillata* Say.
2. Wings of *Basiæschna janata* Say.
3. Wings of *Boyeria irene* Fonscombe.

Plate XXXVIII.

Fig. 1. Wings of *Hoplonæschna armata* Hagen.
2. Wings of *Brachytron pratense* Müller.
3. Wings of *Æschnophlebia anisoptera* Selys.

Plate XXXIX.

Fig. 1. Wings of *Nasiæschna pentacantha* Rambur.
2. Wings of *Staurophlebia reticulata* Burmeister.
3. Wings of *Gynacantha trifida* Rambur.

PLATE XL.

Fig. 1. Wings of *Æschna californica* Calvert.
2. Wings of *Æschna ingens* Rambur.
3. Wings of *Anax junius* Drury.

PLATE XLI.

Fig. 1. Wings of *Synthemis brevistyla* Selys.
2. Wings of *Didymops transversa* Say.
3. Wings of *Palæophlebia superstes* Selys, female.

PLATE XLII.

Fig. 1. Wings of *Neocordulia androgynis* Selys.
2. Wings of *Oxygastra curtisii* Dale.
3. Wings of *Hemicordulia tau* Selys.

PLATE XLIII.

Fig. 1. Wings of *Gomphomacromia paradoxa* Brauer.
2. Wings of *Nannothemis bella* Uhler.
3. Wings of *Perithemis domitia* Drury.

PLATE XLIV.

Fig. 1. Wings of *Agrionoptera insignis* Rambur.
2. Wings of *Anatya guttata* Erichson.
3. Wings of *Raphismia bispina* Hagen.

PLATE XLV.

Fig. 1. Wings of *Pseudophlebia minima* Kirby.
2. Wings of *Diplacodes parvula* Rambur.
3. Wings of *Mesothemis simplicicollis* Say.

PLATE XLVI.

Fig. 1. Wings of *Macrothemis celeno* Selys.
2. Wings of *Celithemis eponina* Drury.
3. Wings of *Leucorhinia intacta* Hagen.

PLATE XLVII.

Fig. 1. Wings of *Pachydiplax longipennis* Burmeister.
2. Wings of *Ephidatia longipes* Hagen.
3. Wings of *Paltothemis lineatipes* Karsch.

PLATE XLVIII.

Fig. 1. Wings of *Orthemis ferruginea* Fabricius.
2. Wings of *Belonia uniformis* Kirby.
3. Wings of *Libellula pulchella* Drury.

PLATE XLIX.

Fig. 1. Wings of *Schizopyga luctifera* Selys.
2. Wings of *Tauriphila iphigenia* Hagen.
3. Wings of *Tramea onusta* Hagen.

PLATE L.

Fig. 1. Wings of *Trithemis* sp?
2. Wings of *Uracis* sp?
3. Wings of *Pantala flavescens* Fabricius.

PLATE LI.

Fig. 1. Wings of *Pseudophæa ochracea* Selys.
2. Wing of *Epallage fatima* Charpentier.
3. Wings of *Cyanocharis valga* Needham.
4. Wing of *Hetærina* sp? (from Brazil).
5. Wing of *Rhinocypha trifasciata?* Selys.
6. Wing of *Archilestes grandis* Rambur.
7. Wing of *Megalestes major* Selys.
8. Wing of *Mecistogaster lucretia* Drury.

PLATE LII.

Fig. 1. Wing of *Micromerus blandus* Selys.
2. Wing of *Libellago caligata* Selys.
3. Wing of *Pseudophæa* sp?
4. Wing of *Epallage fatima* Charpentier.
5. Wing of *Rhinocypha* sp?

PLATE LIII.

Fig. 1. Wing of *Lestes tricolor* Erichson.
2. Wing of *Palæmna sp?* (from Trinidad).
3. Wing of *Platysticta maculata* Selys.
4. Wing of *Philogenia* sp?
5. Wing of *Argia fumipennis* Burmeister.
6. Wing of *Heteragrion flavovittatum* Selys.
7. Wing of *Agriocnemis pulverulans* Selys.
8. Wing of *Amphipteryx agrioides* Selys.

PLATE LIV.

Fig. 1. Wing of *Tatocnemis malgassica* Kirby.
2. Wing of *Disparoneura* sp?
3. Wing of *Idioneura ancilla* Selys.
4. Wing of *Cœnoneura carnatica* Selys.
5. Wing of *Hesperagrion heterodoxum* Selys.
6. Wing of *Enallagma annexum* Hagen.
7. Wing of *Erythragrion salvum* Hagen.
8. Wing of *Nehallennia irene* Hagen.

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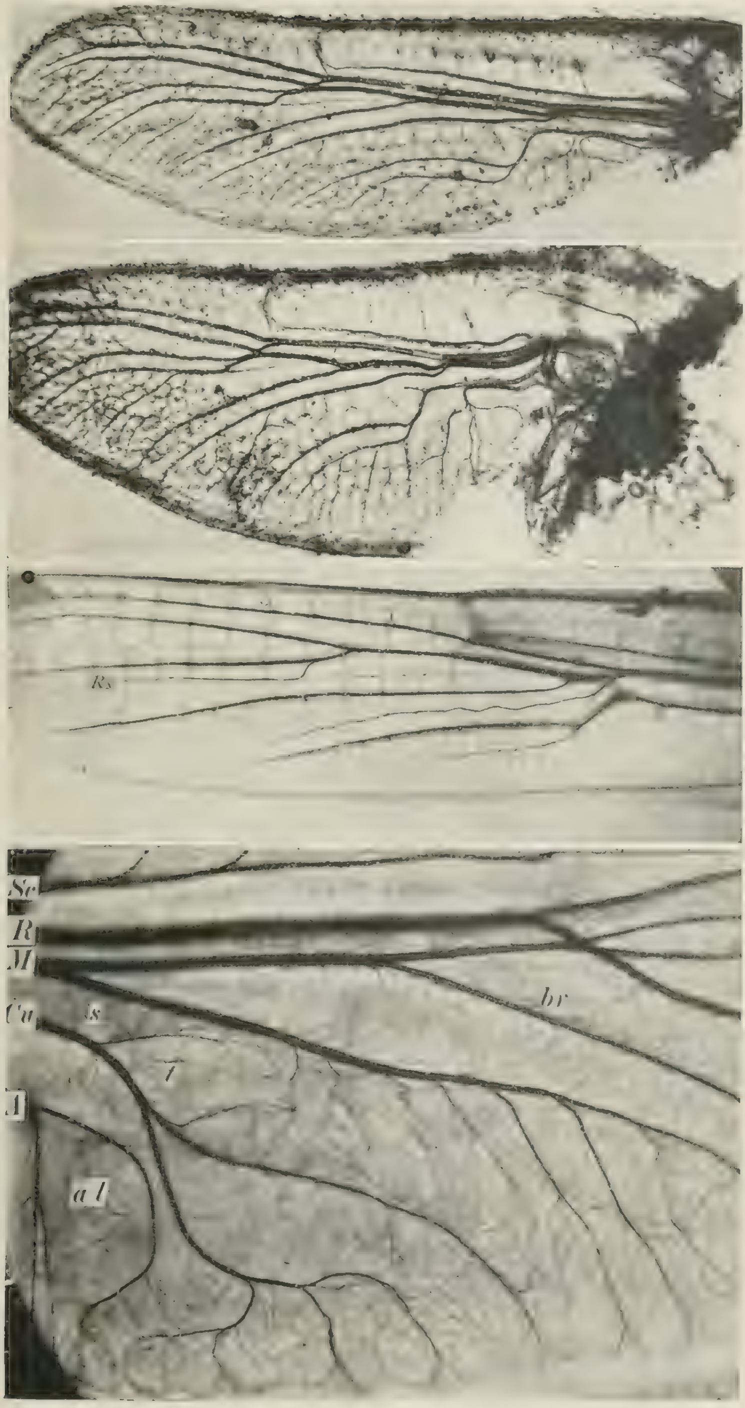

Dragon-fly Wing Venation.

For explanation of plate see page 762.

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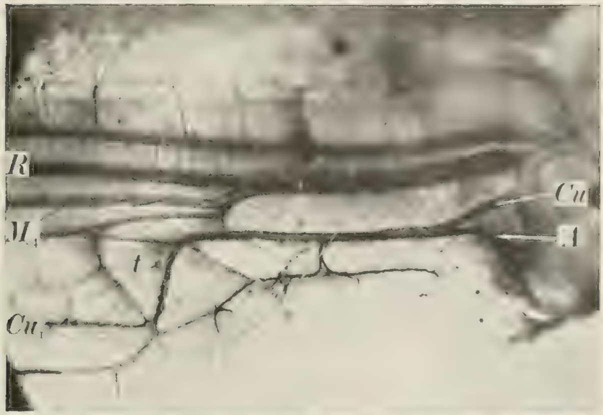

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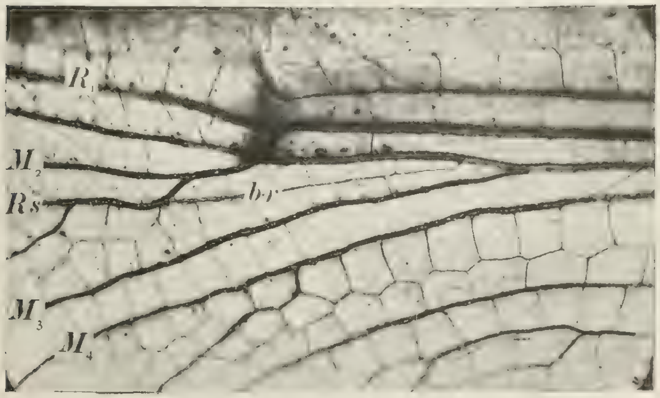
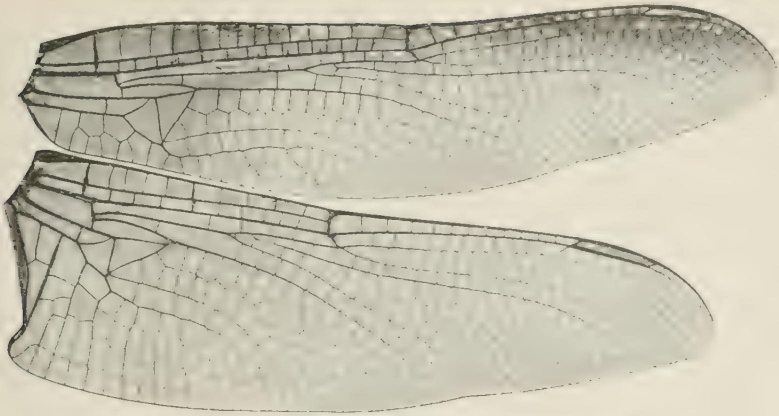


DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 762.



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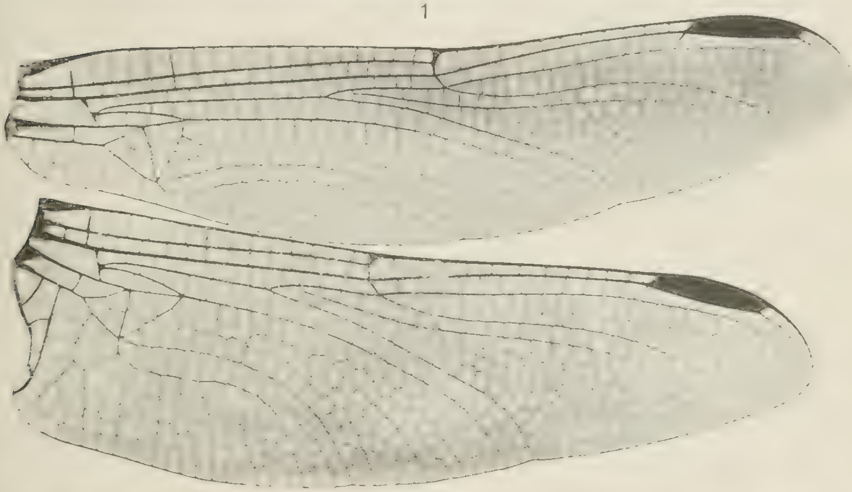

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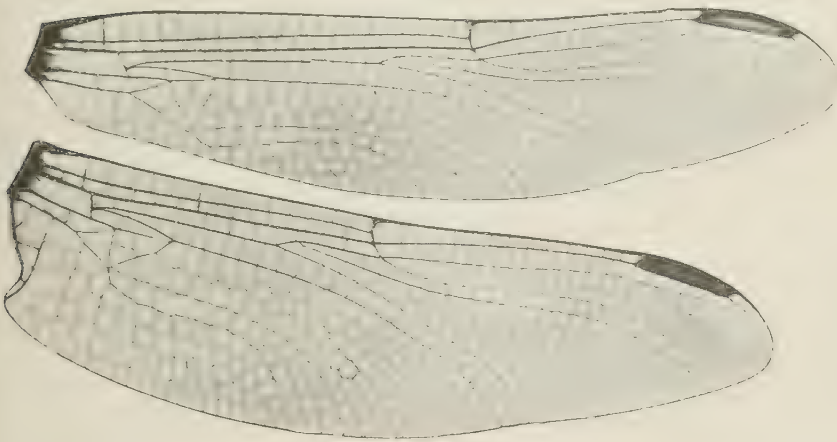

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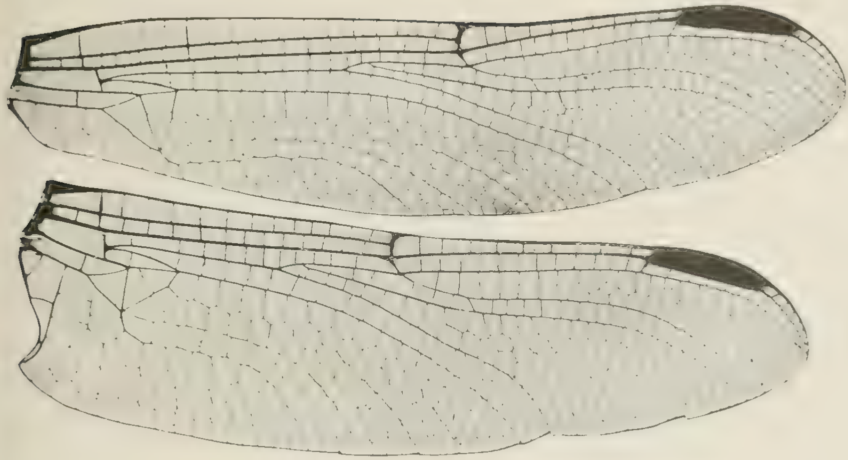
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 762.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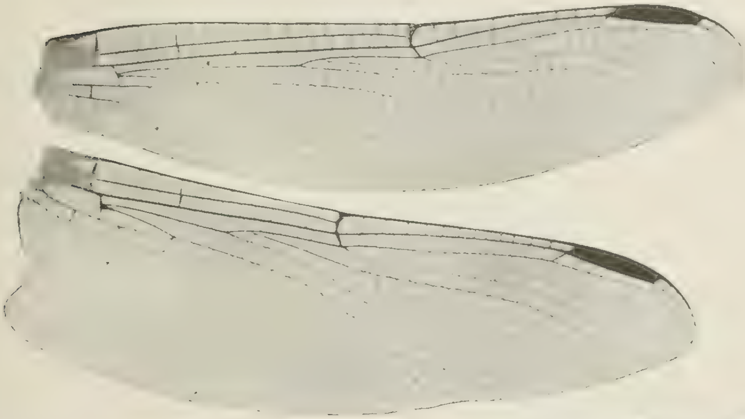
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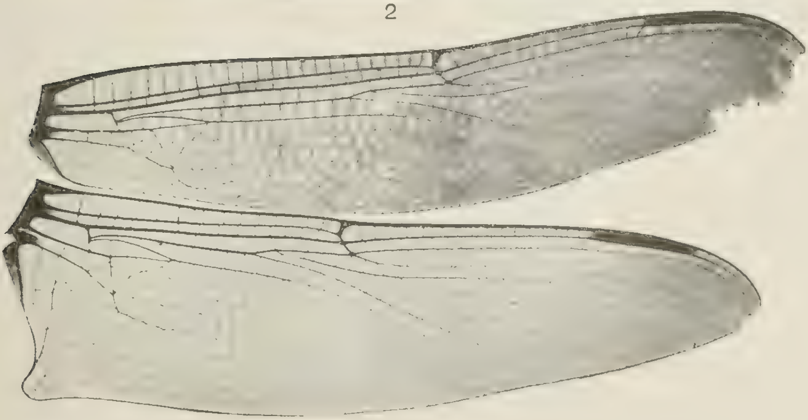
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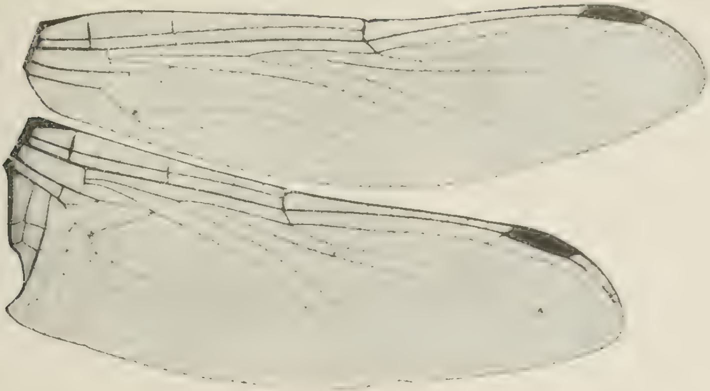
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 762.



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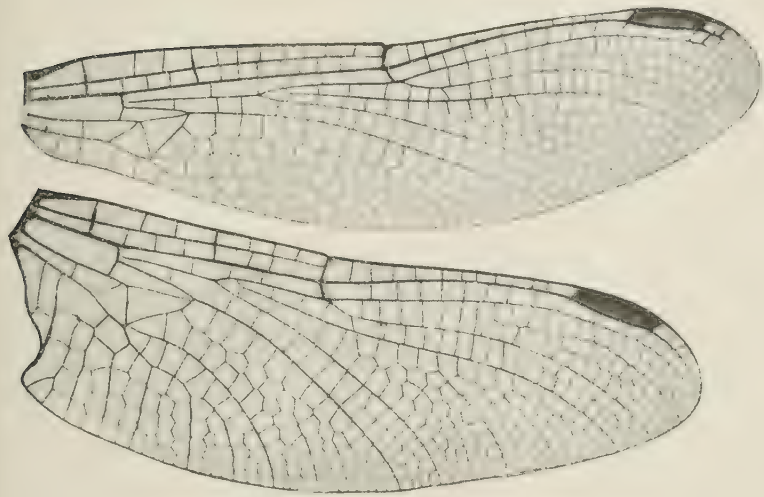

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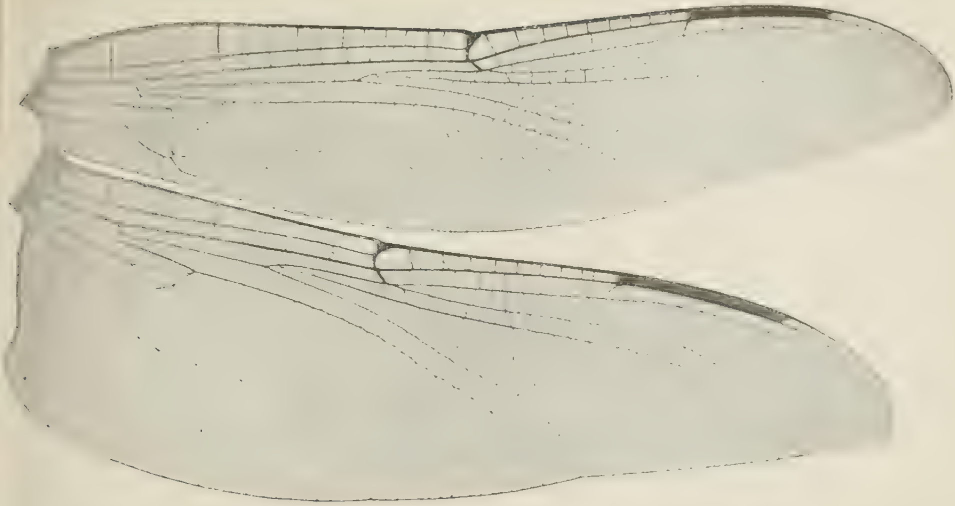
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 762.



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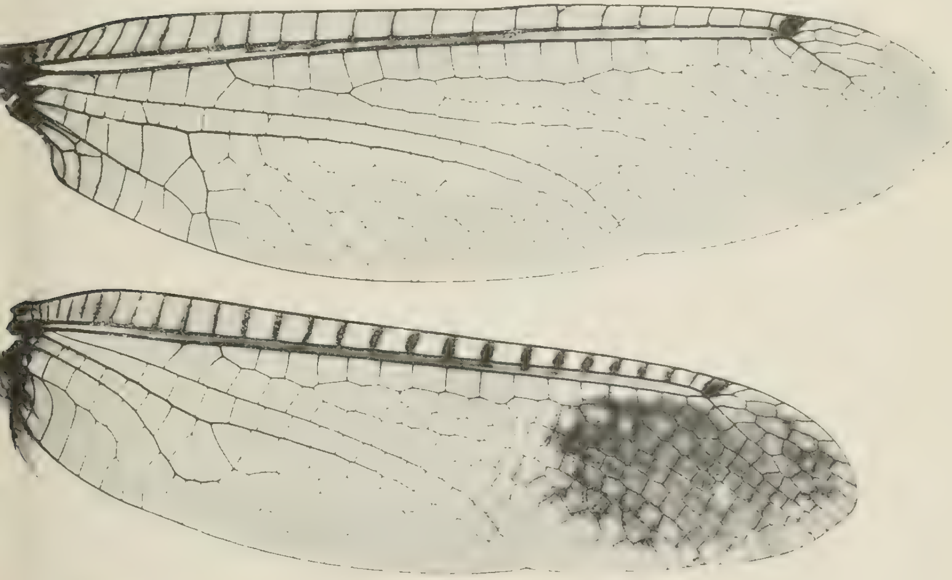

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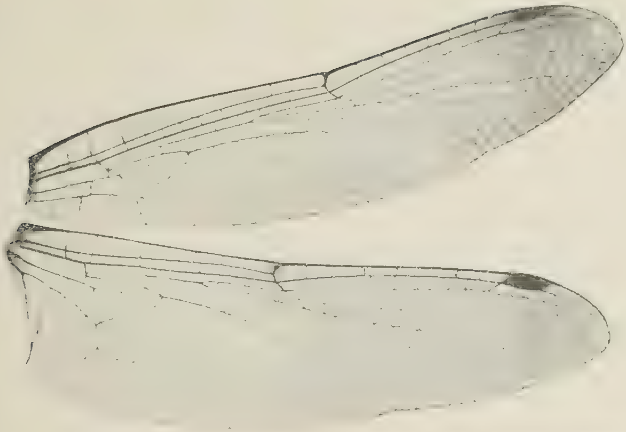
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 762.



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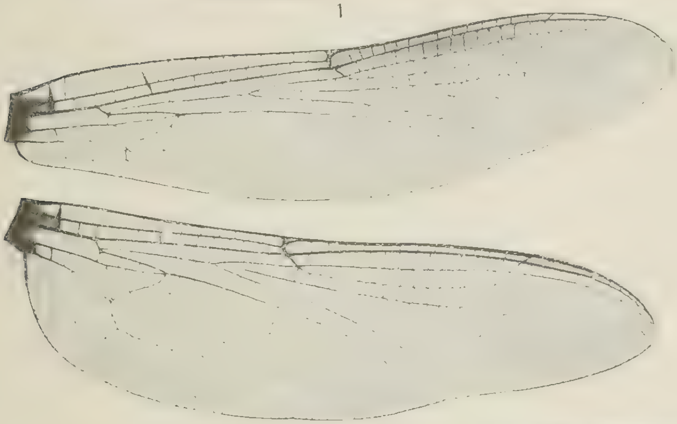

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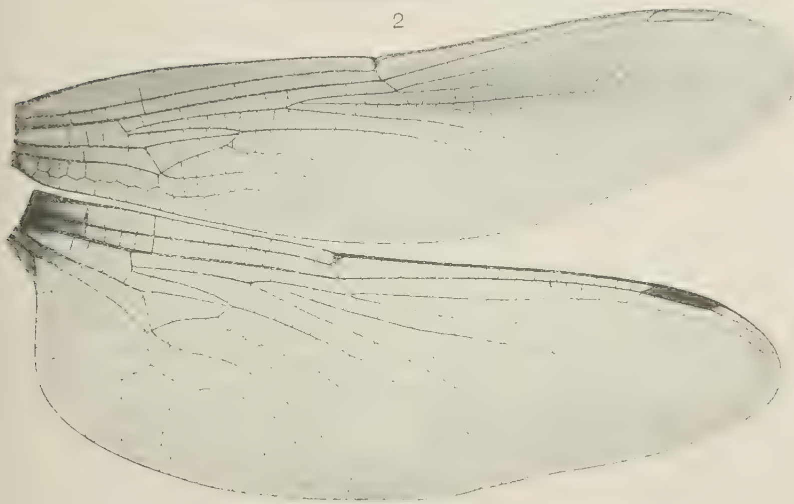

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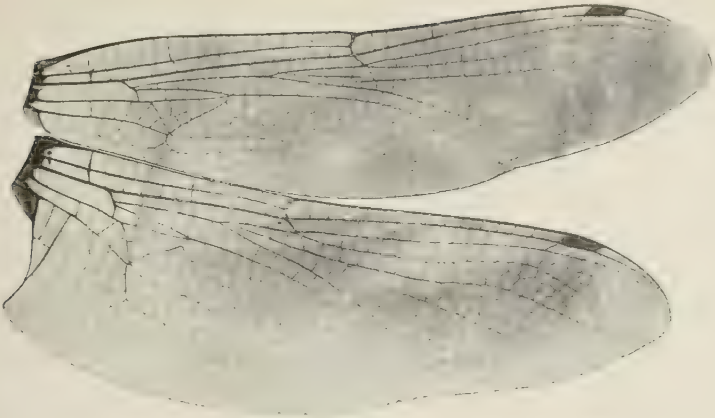
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 762.



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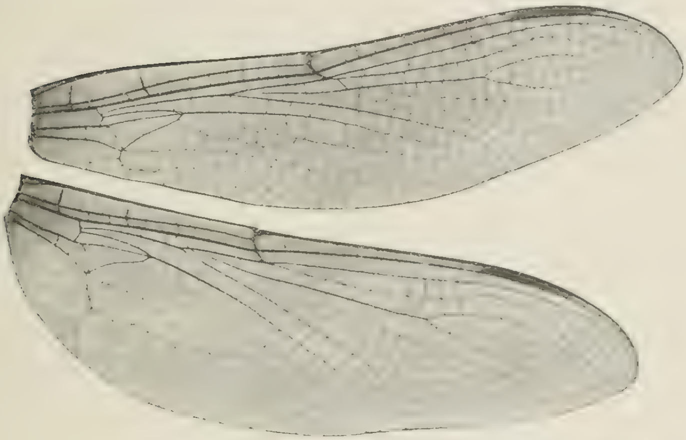

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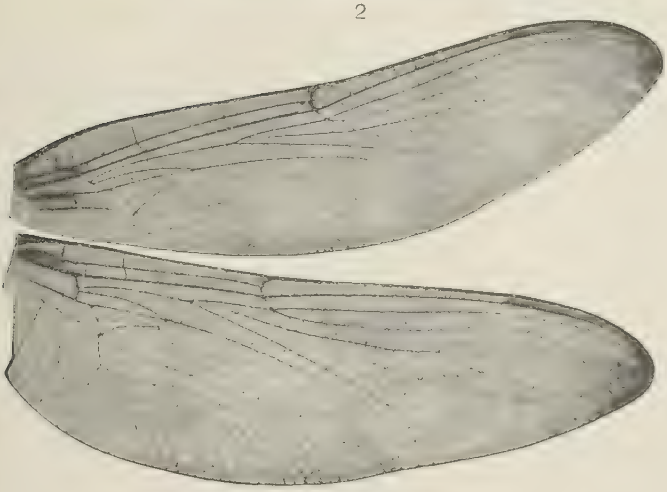

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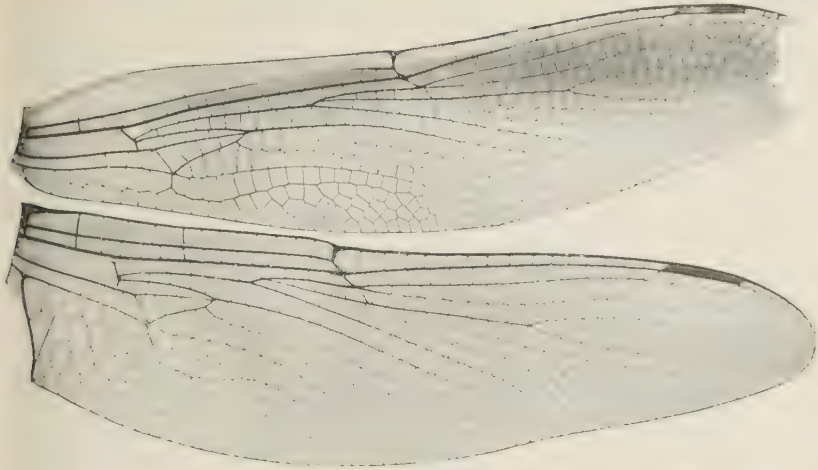
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 762.



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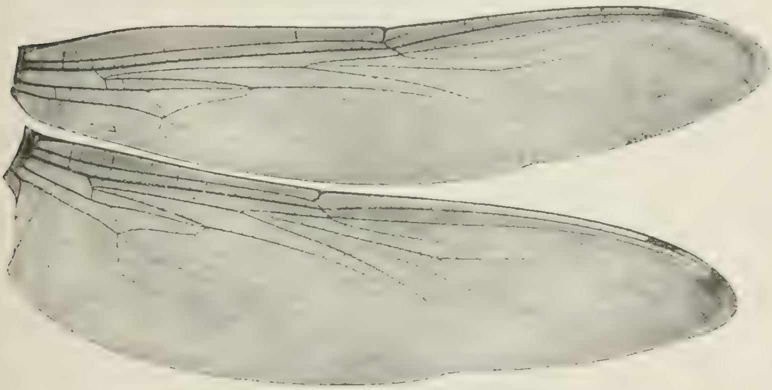

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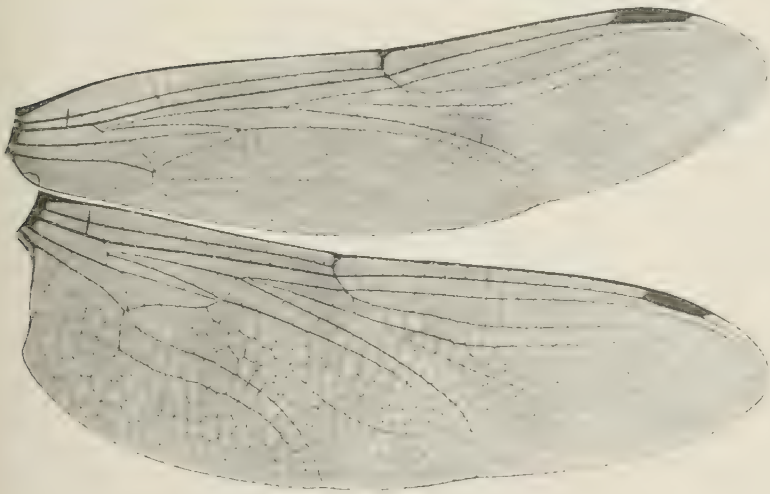

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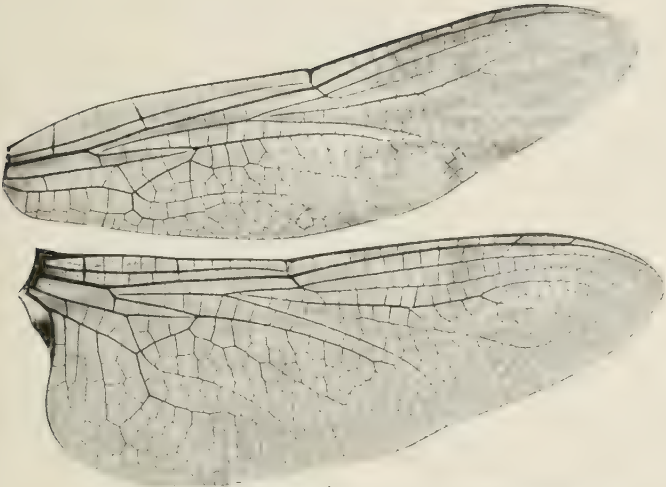
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 762.



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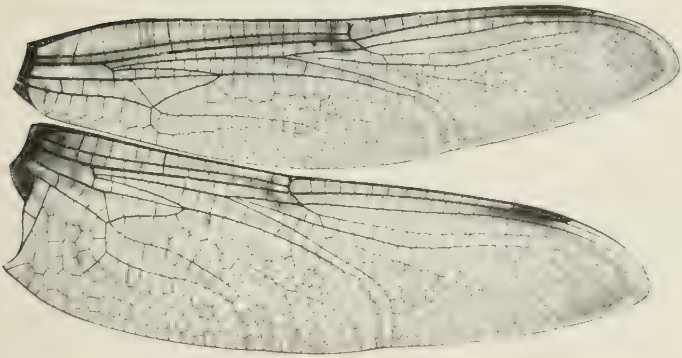

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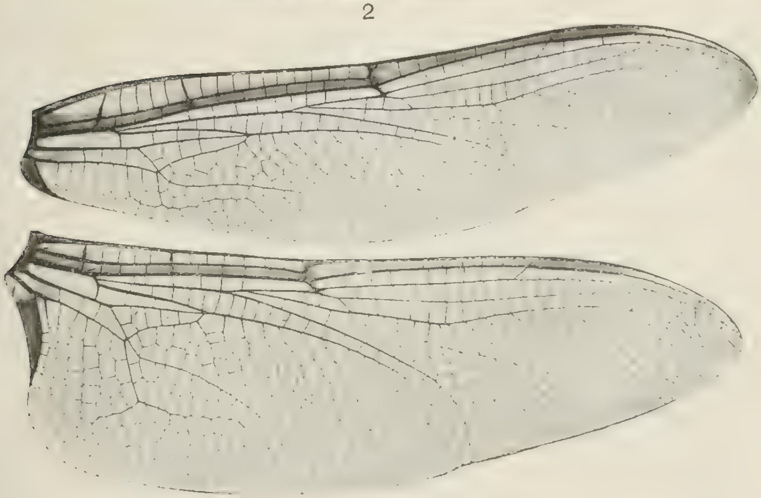

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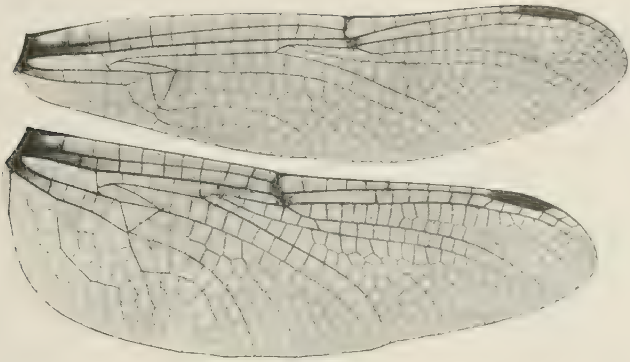
Dragon-fly Wing Venation.

For explanation of plate see page 763.



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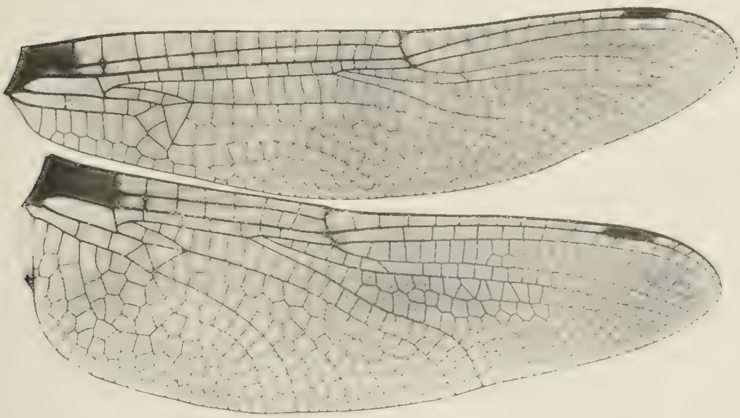

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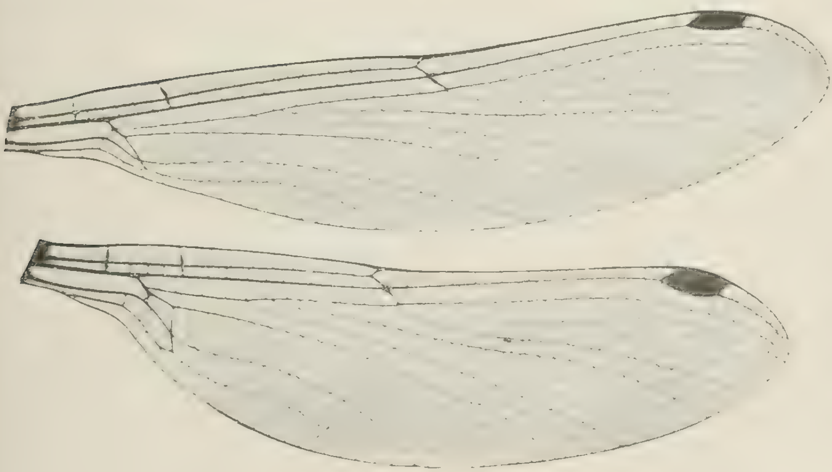

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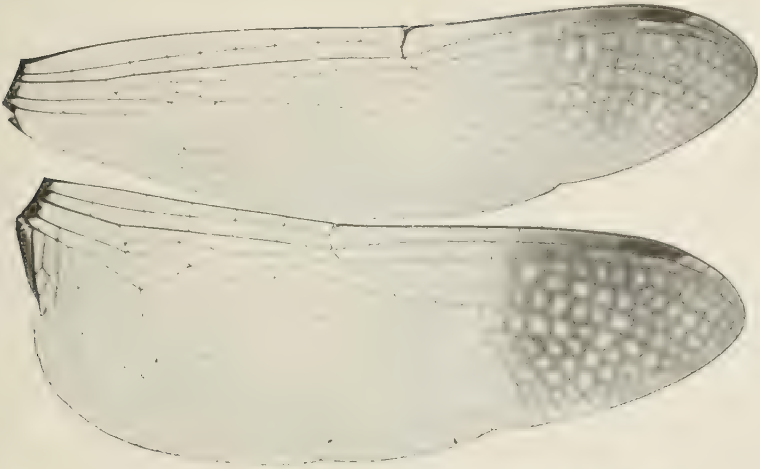
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.



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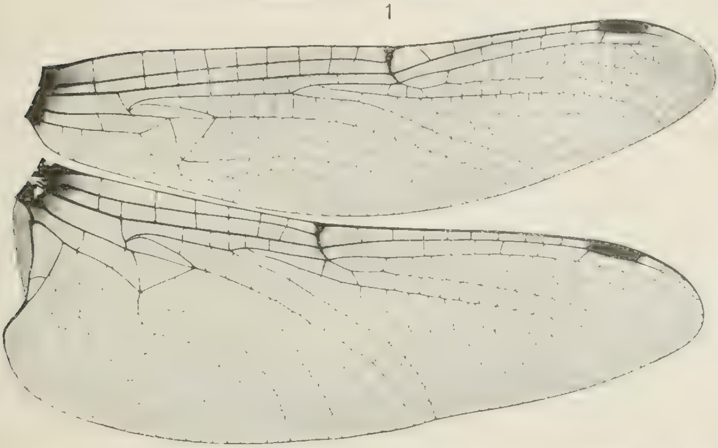

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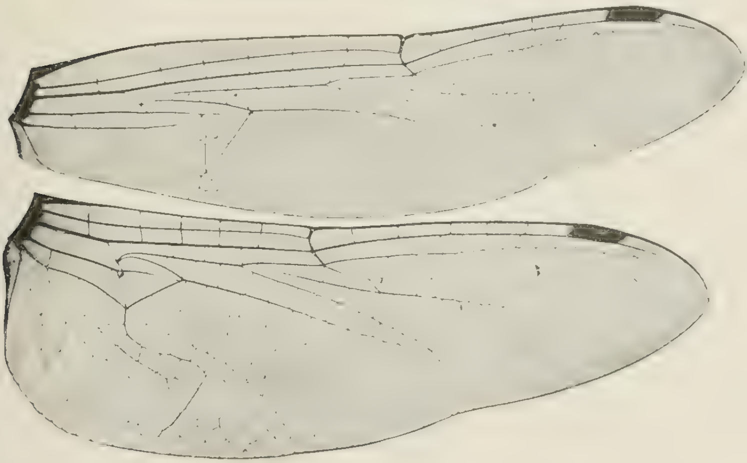

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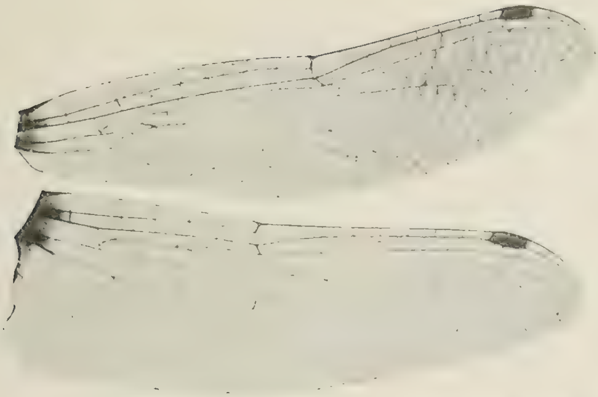
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.



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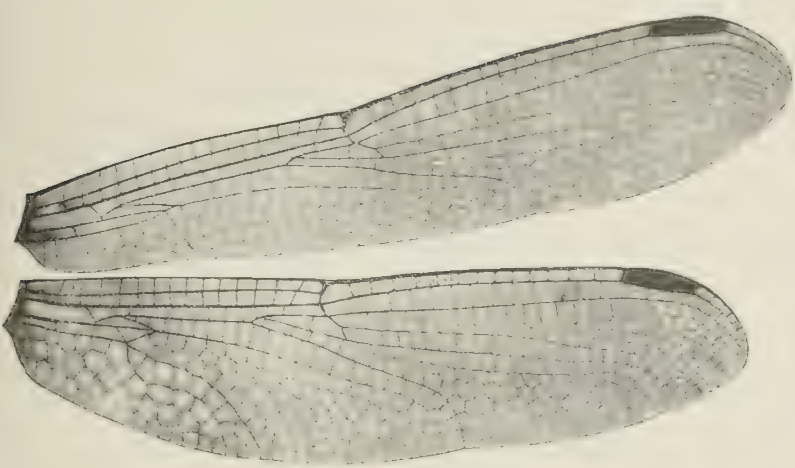
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.



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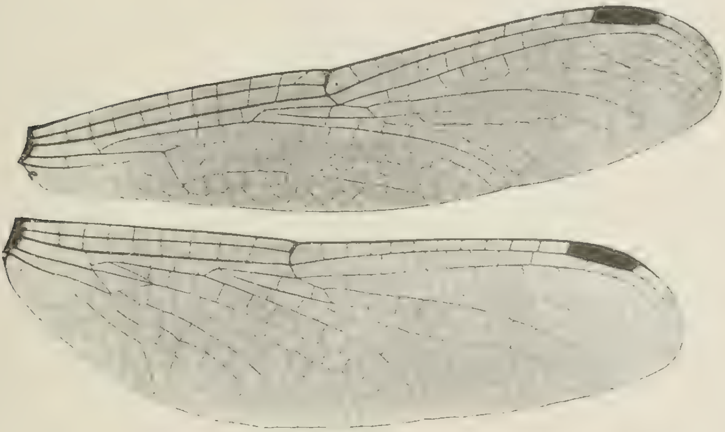

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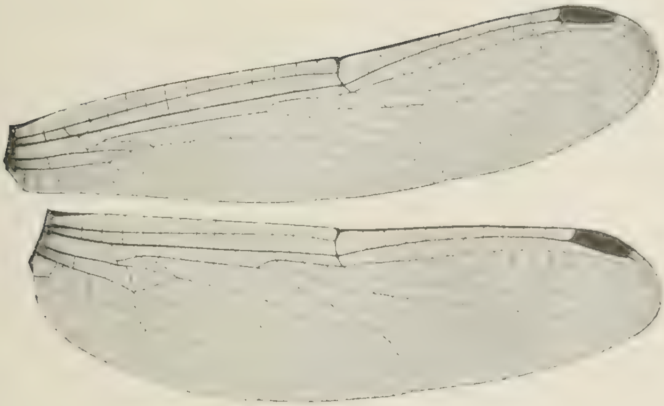
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.



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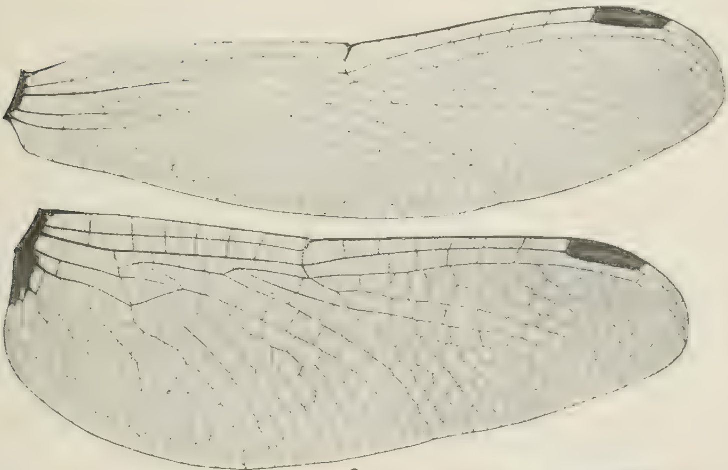

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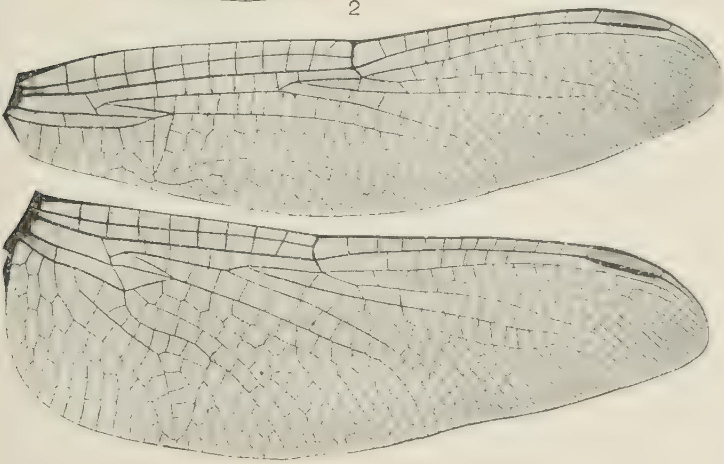

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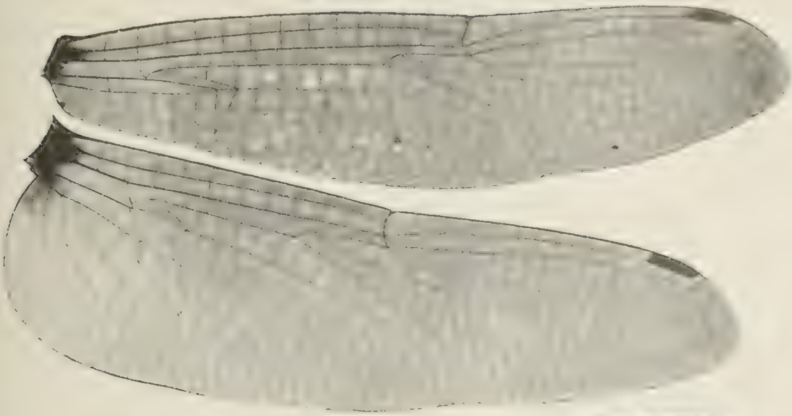
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.



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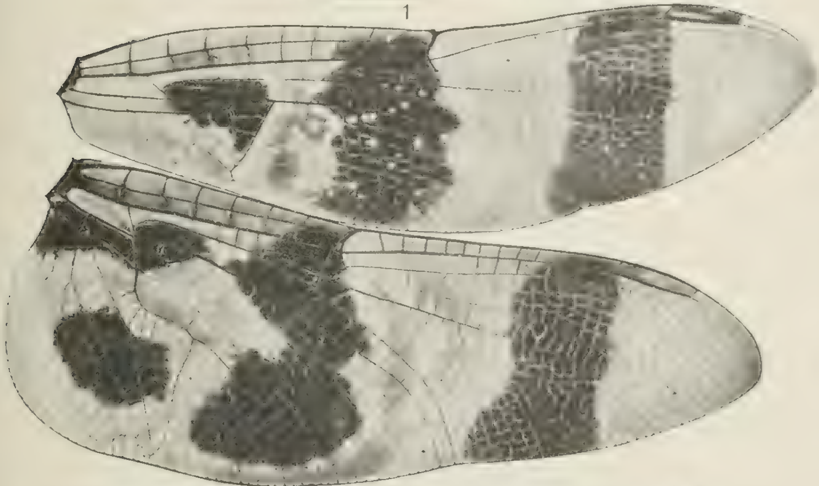

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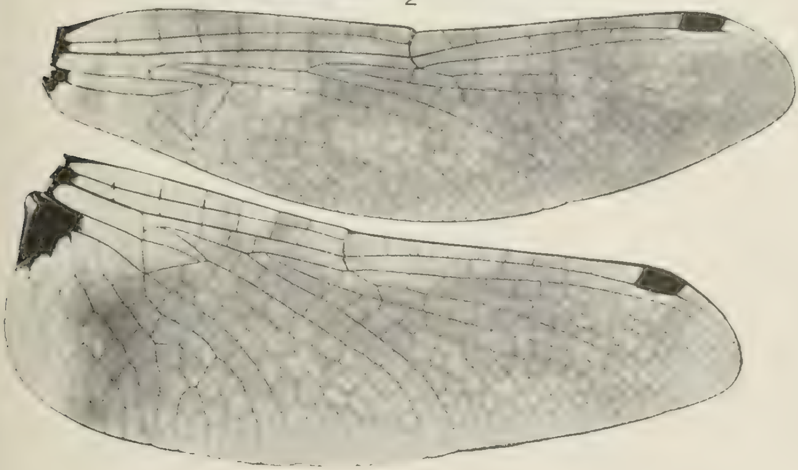

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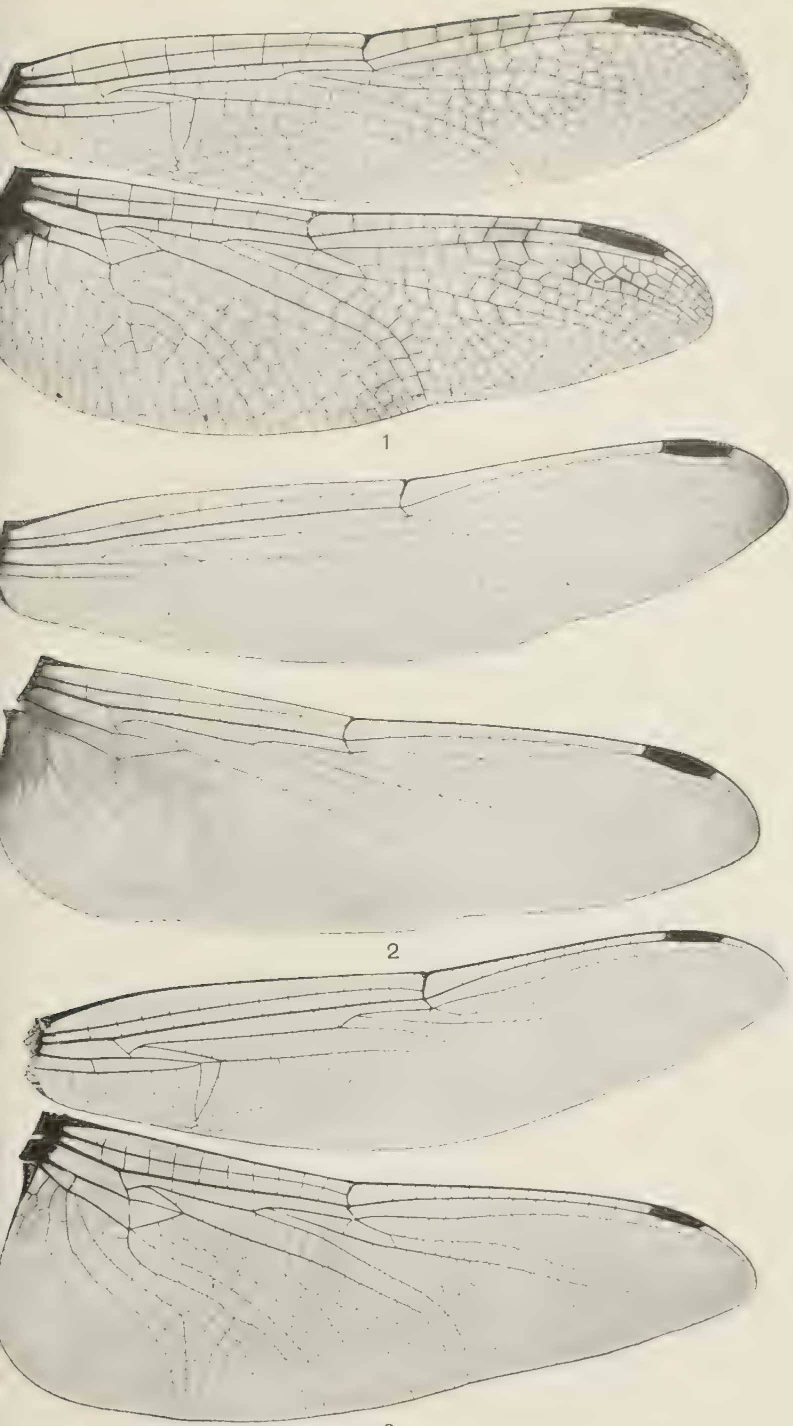
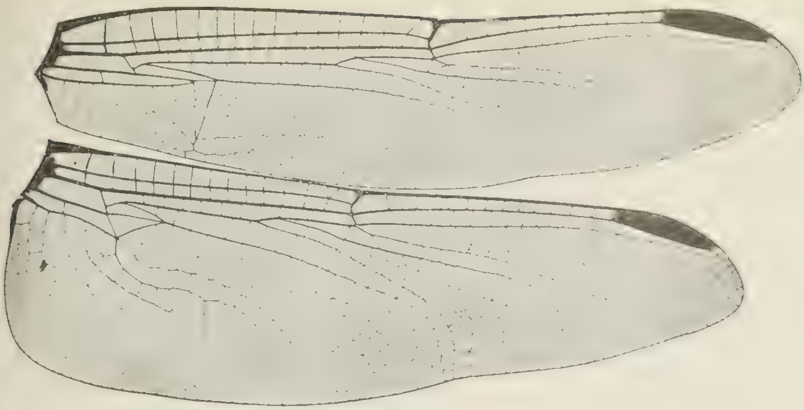
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.



DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.



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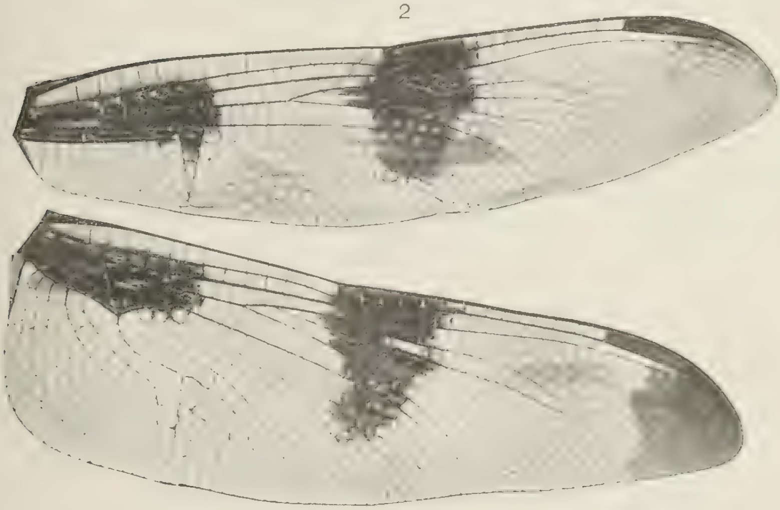

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DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.


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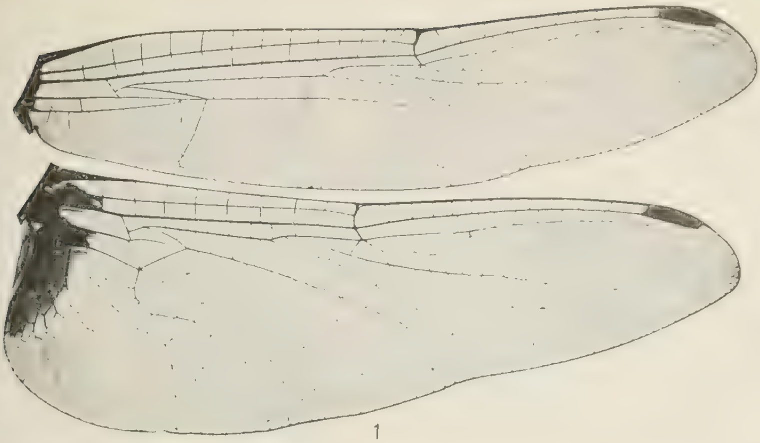
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 763.



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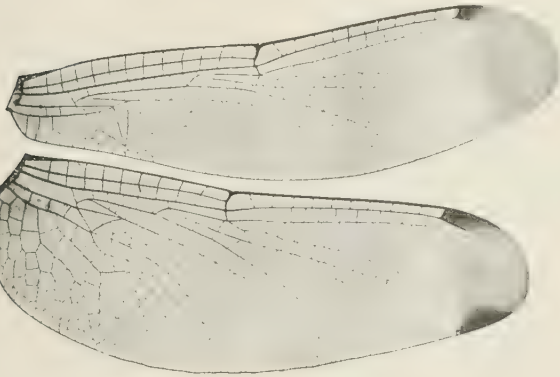

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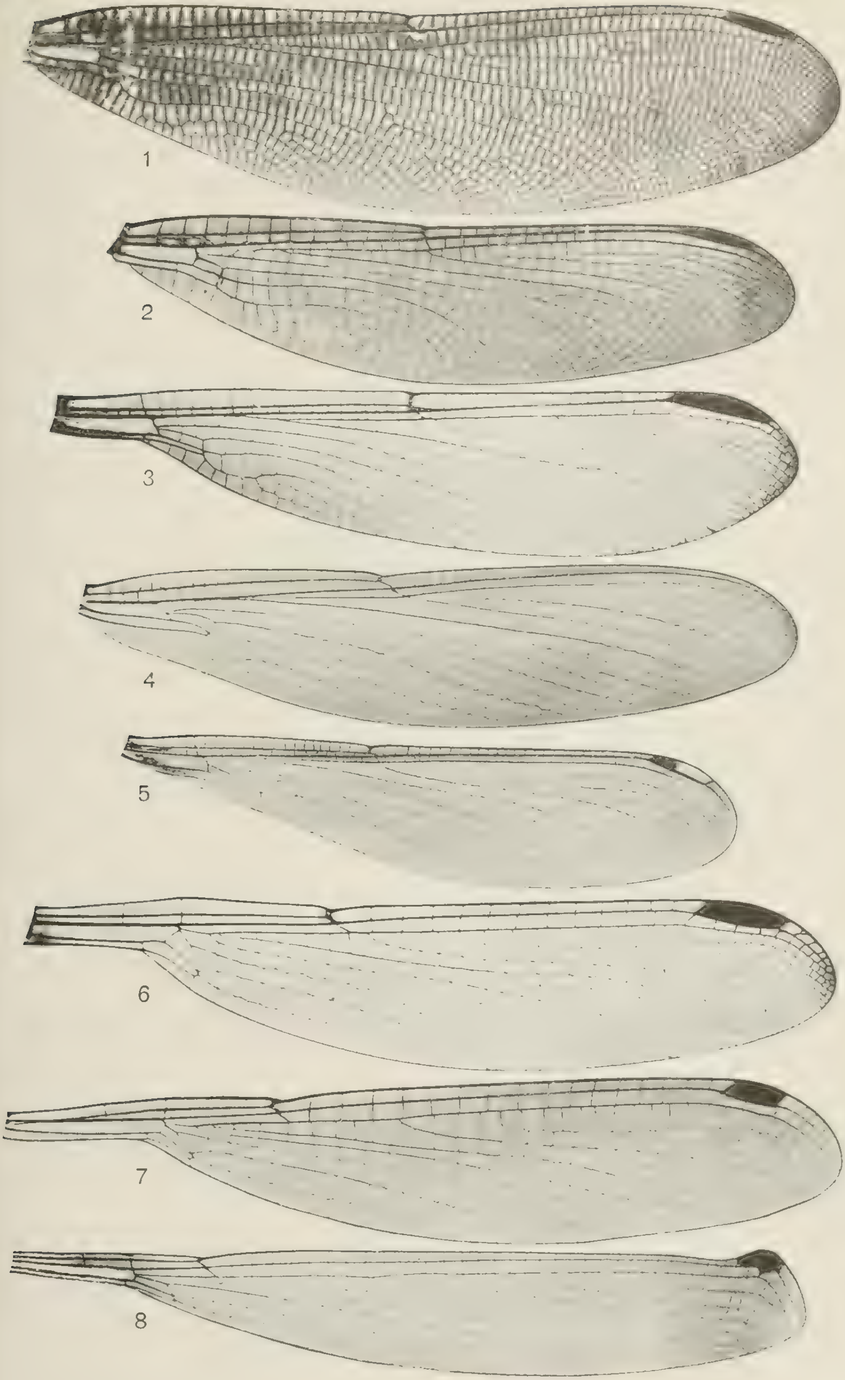
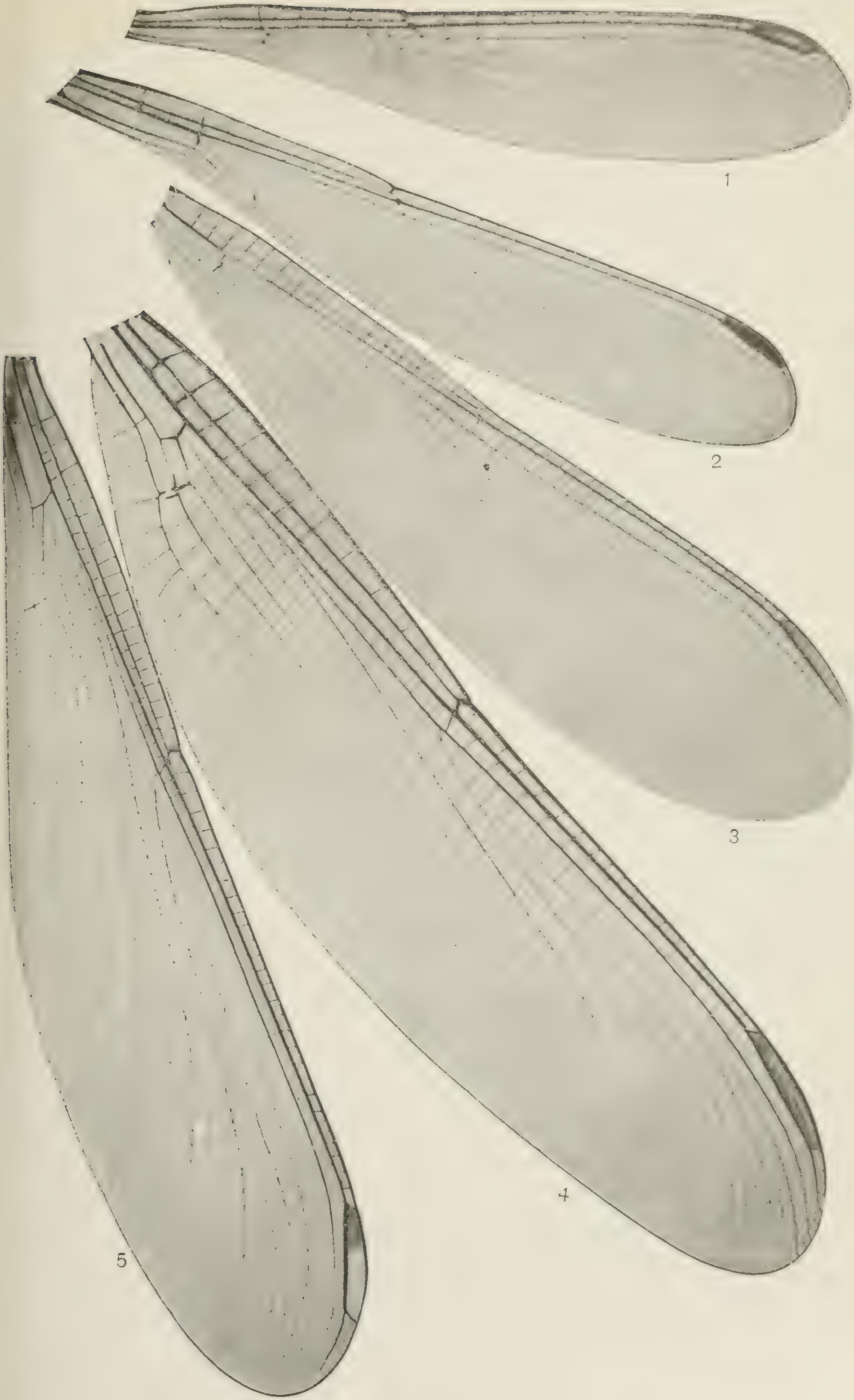
Dragon-fly Wing Venation.

For explanation of plate see page 764.



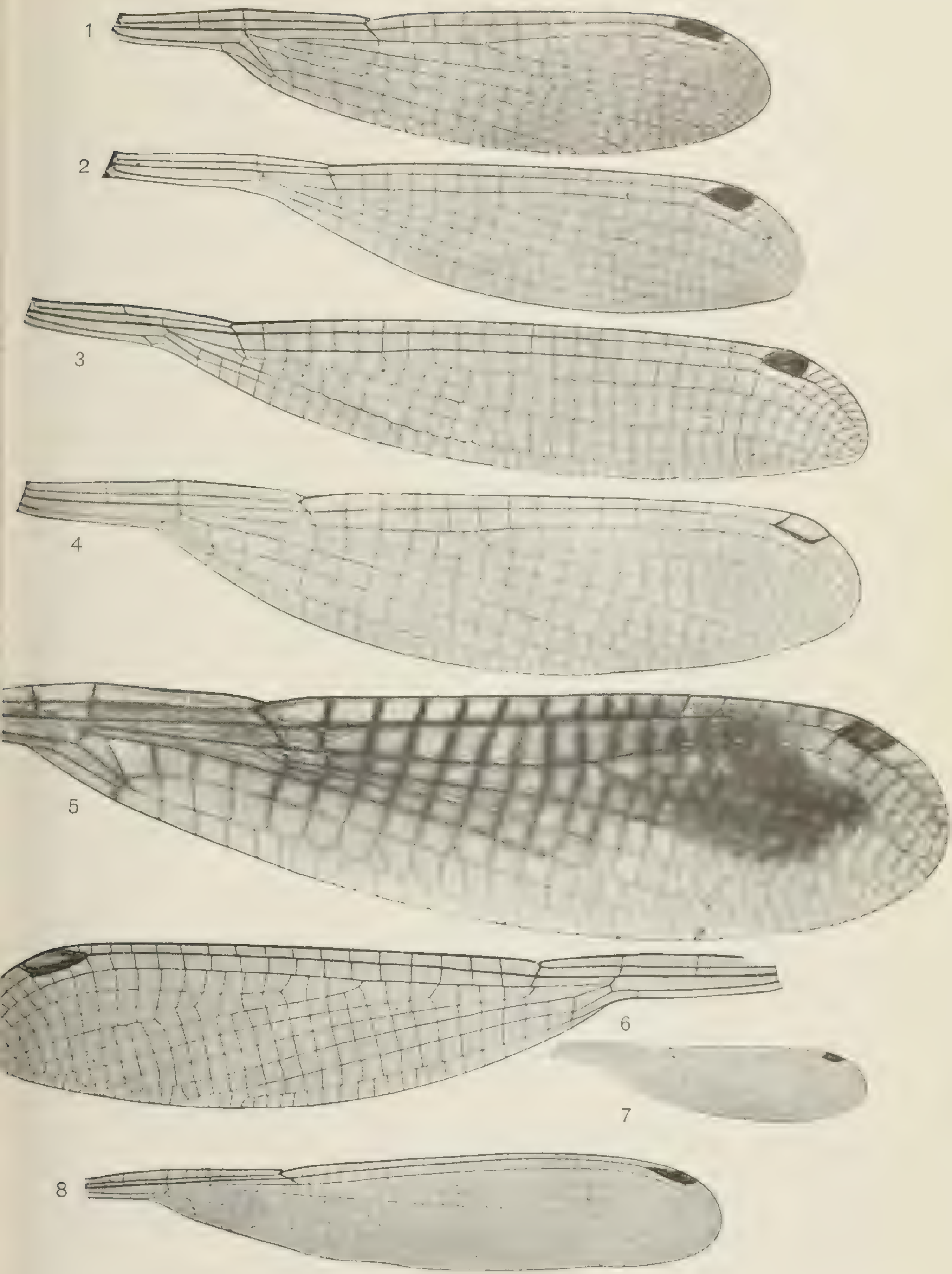
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 764.



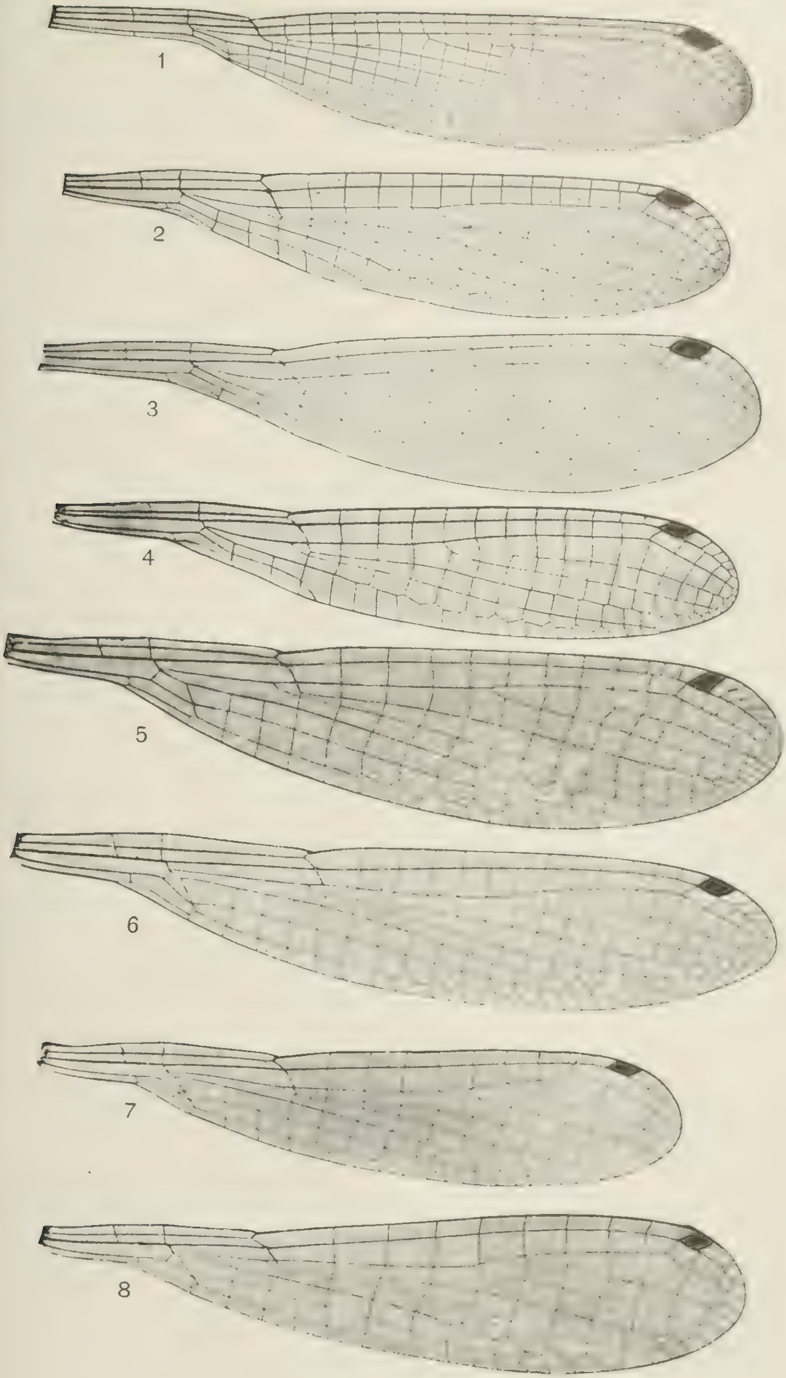
DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 764.



DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 764.



DRAGON-FLY WING VENATION.

FOR EXPLANATION OF PLATE SEE PAGE 764.

A REVIEW OF THE COBITIDÆ, OR LOACHES, OF THE RIVERS OF JAPAN.

By David Starr Jordan and Henry W. Fowler,
Of the Leland Stanford Junior University.

In the present paper is given an account of the species of *Cobitidæ*, small fishes known in English as loach, in Japanese as Dojo, recorded from the streams and lakes of Japan. It is based on the collections made by Messrs. Jordan and Snyder in 1900, preserved in the U. S. National Museum and in the collections of Leland Stanford Junior University. The plates are by Mrs. Chloe Lesley Starks.

Family COBITIDÆ.

Body more or less elongate, oblong, compressed, or cylindrical, but never depressed. Head depressed or compressed; snout more or less fleshy, blunt, inferior; the lips fleshy and furnished with from 6 to 12 barbels. Pharyngeal teeth few, in one row and in moderate number; no pseudobranchiæ. Scales small, rudimentary, or entirely absent; cycloid, when present, usually immersed in mucous skin, and rarely present on the head. Lateral line single; air vessel entirely or partially inclosed in bone. Vertical fins spineless, the dorsal rays varying from 8 to 30, the anal with about 7 or 8, and the ventrals sometimes absent. Small fishes confined to the rivers of the Old World in Europe and Asia. They are used as food.

a. No erectile spines below the eye.
- *b*. Barbels 10 or 12; 4 about the mandible; dorsal, short; caudal rounded; lateral line medium .... *Misgurnus*, 1.
- *bb*. Barbels 6 or 8; none about the mandible.
  - *c*. Barbels 8, a pair of nasal barbels being present; dorsal short; caudal rounded; lateral line obsolete .... *Elxis*, 2.
  - *cc*. Barbels 6, no nasal barbels being present; dorsal fin short; caudal fin truncate; lateral line median .... *Orthrias*, 3.

aa. An erectile spine below the eye.
- *d*. Caudal fin rounded; lateral line incomplete; dorsal short .... *Cobitis*, 4.
- *dd*. Caudal fin deeply forked.
  - *e*. Barbels 6; body rather robust; lateral line complete; dorsal rather long. *Hymenophysa*, 5.

1. MISGURNUS Lacépède.

Misgurnus LACÉPÈDE, Hist. Nat. Poiss., V, 1803, p. 16 (*fossilis*).

Body elongate, compressed. Head triangular, elongate, compressed snout projecting; mouth inferior, with fleshy lips; barbels 10 or 12, o which 4 are mandibular; eye small. Gill-openings lateral; lateral lin complete. No spine below the eye. Body with small scales, excep on the head, which is naked. Origin of the dorsal about in the middl of the length of the fish, over the ventrals; anal entirely behind dor sal; pectorals more or less equal to the head; caudal nearly equal t head, and rounded. Air-bladder in a bony capsule.

(*misgurn*, a vernacular name used by Willughby for *Misgurnu fossilis.*)

a. Barbels 12, 4 belonging to the mandible .... *polynemus*, 1

aa. Barbels 10, 4 belonging to the mandible.................... *anguillicaudatus*, 2

1. MISGURNUS POLYNEMUS (Bleeker).

Cobitichthys polynema BLEEKER, Act. Soc. Sci. Indo-Neerl, VIII, 1860, p. 90, p II, fig. 3; (Jeddo=Tokyo).

Misgurnus polynema GÜNTHER, Cat. Fish. Brit. Mus., VII, 1868, p. 346 (aft Bleeker).—JORDAN and SNYDER, Annot. Zool. Japan, III, 1901, p. 45.

D. 10; A. 7; V. 6. Barbels 12; 4 belonging to the mandible. Scale conspicuous. Origin of the dorsal midway between the root of th caudal and the gill-opening; pectoral fin shorter than the head. Colo nearly uniform brownish, tail and caudal fin with scattered blackis spots. Jeddo. (Günther.)

Not seen by us.

(πολύς, many; νῆμα, thread.)

2. MISGURNUS ANGUILLICAUDATUS (Cantor).

DOJO.

Cobitis anguillicaudata CANTOR, Ann. Mag. Nat. Hist., IX, 1842, p. 485.—RIC ARDSON, Ichth. China, 1846, p. 300; Canton.

Misgurnus anguillicaudatus GÜNTHER, Cat. Fish, VII, 1868, p. 345; China, Chusa Japan, Formosa.—JORDAN and SNYDER, Check List, 1901, p. 45.

Cobitis bifurcata McCLELLAND, Calcutta Jour. Nat. Hist., IV, 1844, p. 400, p XXIII, fig. 1; India.

Cobitis pectoralis McCLELLAND, Calcutta Jour. Nat. Hist., IV, 1844, p. 400, p XXIII, fig. 3; India. (Specimens with long pectorals.)

Cobitis rubripinnis SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 220, pl. CIII, fig. near Nagasaki.

Cobitis maculata SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 221, pl. CIII, fig. near Nagasaki.

Cobitis microps CUVIER and VALENCIENNES, Hist. Nat. Poiss., XVIII, 1846, p. 2 China.

Cobitis psammismus RICHARDSON, Ichthy. China, 1846, p. 300; Canton.

Cobitis decemcirrosus BASILEWSKY, Mem. Soc. Nat. Mosc., 1855, p. 239; ne Peking.

Cobitichthys enalios BLEEKER, Act. Soc. Sci. Indo-Neerl., VIII, 1860, Japan, VI, p. 88, pl. II, fig. 4; Japan; specimens with long pectorals.

Cobitichthys dichachrous BLEEKER, Act. Soc. Sci. Indo-Neerl., VIII, 1860, Japan; IV, p. 89, pl. II, fig. 2; Yeddo (Tokyo); specimens bicolor, the two shades sharply defined.

Misgurnus dichachrous GÜNTHER, Cat. Fish, VII, 1868, p. 346; Yeddo; same specimens.

Head 6 in length; depth $6\frac{3}{5}$; D. 9; A. 8; P. I. 9; V. 6; width of head 2 in its length; eye 3 in snout, $1\frac{2}{3}$ in interorbital space; snout $2\frac{1}{3}$ in head; pectoral $1\frac{3}{5}$; ventrals $2\frac{1}{2}$; scales about 150.

Body elongate, greatly compressed. Head small, triangular, and compressed; snout long, obtuse, rounded and produced; eyes small, anterior and superior; mouth inferior, with thick fleshy lips; barbels 10, of which 4 are on the lower jaw; nostrils close together and in front of the eye, the first pair in a short tube; interorbital space slightly convex, much less than the length of the snout; cheeks not swollen. Gill-openings lateral, joined below in front of the base of the pectoral.

Head naked, the trunk covered with small cycloid scales.

Origin of the dorsal about midway in the length of the body, including caudal, and directly over the ventrals, the fin short; anal entirely behind the dorsal, and nearer the origin of the ventrals than the base of the caudal; caudal oblong, broad, rounded, and about equal to the head; pectorals short and low; ventrals short. Caudal peduncle long and deep, its depth about three-fourths the head. Lateral line medium along the sides to the base of caudal.

Color in alcohol dark gray-brown, above spotted and marbled with darker, the spots smaller on the tail, and those on the caudal and dorsal fins very small; sides of the body with many narrow more or less even longitudinal blackish stripes; lower parts of the body together with the ventrals and anal, pale; pectoral pale, except some dusky on the upper part of the longer rays.

Length $7\frac{3}{8}$ inches.

This description from a specimen from the Yodo River in Osaka.

Of this species, which is very abundant in all the rivers and lakes of Japan we have many examples. They are from Junsai Lake in Aomori, Hakodate, from the Sapporo Museum, Tsuchiura, Niigata, Aomori, Sendai, the Yodo River in Osaka, the Iwai River at Ichinoseki, and at Morioka, Misaki, Tokyo, Nagasaki, and Formosa.

In this large series we are unable to distinguish more than one species, subject to great variations. In some examples the lower surface of the body is mottled or spotted like the back. We also notice many examples, as Dr. Günther has observed, with deep bodies and adipose layers along the rudimentary caudal rays, perhaps better fed than usual.

(*anguilla*, eel; *caudatus*, tailed.)

2. ELXIS Jordan and Fowler.

Elxis Jordan and Fowler, new genus (*nikkonis*).

Body moderately elongate, compressed; head elongate, sometimes depressed; eyes small; snout produced and rounded; mouth inferior, with fleshy lips and four rostral, two maxillary, and two nasal barbels, none on the mandible; scales large and cycloid; lateral line incomplete; caudal rounded, sometimes longer than the head; pectorals variable; gill openings lateral; color variegated with blotches and mottlings, and usually a dark spot at base of caudal. Small loaches, of the waters of Japan.

(ἕλξις, a trailing.)

3. ELXIS NIKKONIS Jordan and Fowler, new species.

Head $4\frac{1}{2}$ in length; depth $6\frac{1}{2}$; D. 8; A. 7; P. 12; V. 6; scales about 56; width of head $1\frac{1}{2}$ in its length; snout 3 in head; interorbital space $2\frac{1}{2}$; pectoral $1\frac{1}{2}$; ventral $1\frac{2}{3}$; eye 2 in interorbital space.

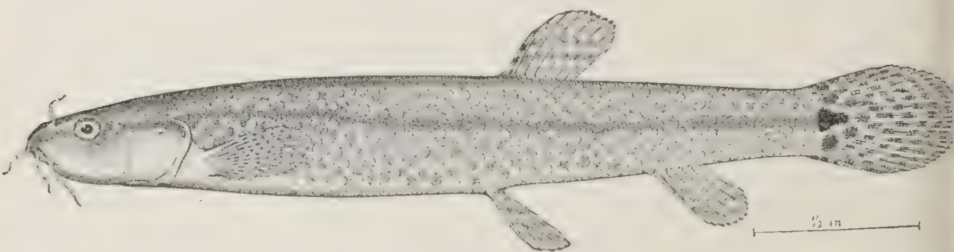


Fig. 1.—Elkis nikkonis.

Body elongate and rather slender, the tail compressed. Head broad, depressed, and elongate; snout broad, depressed, rounded, and produced; eyes small, anterior, lateral; mouth rather broad, inferior and with fleshy lips; barbels 8, of which there is a nasal pair, and the maxillary pair is the longest, though there are no mandibulars; interorbital space very broad and depressed like the top of the head, flattened; nostrils large, in front of the eyes above. Gill openings rather large, lateral and joined below the base of the pectoral in front.

Scales on the body rather large and cycloid, none on the head.

Origin of the dorsal nearer the tip of the caudal than the tip of the snout, about equal to the height of the body, and its length, when depressed, about three-fourths the length of the head; anal entirely behind dorsal and reaching two-thirds of the space between its origin and the base of the caudal; caudal less than head, and rounded; pectorals small, low, reaching about two-fifths in the space between their origins and those of the ventrals; ventrals a little before the origin of the dorsal, nearer the gill opening than the base of the caudal, and reaching more than half the distance between their own origins and that of the anal. Caudal peduncle long, equal to head without snout

and its greatest depth $2\frac{1}{2}$ in the length of the head. Lateral line absent.

Color in alcohol brown, dark on the back, and top of the head, with small blotches and mottlings of deeper; along the sides a rather irregularly defined longitudinal dark band, ending in a blackish spot at the base of the middle caudal rays; all the fins more or less spotted with dark brown, deepest, best defined, and largest on the dorsal and caudal; lower surface of the body pale or whitish.

Length $2\frac{13}{16}$ inches.

Type No. 7848, Ichthyological Collections Leland Stanford Junior University Museum. Locality, Chitose, in Iburi, Hokkaido.

Of this species we have a number of examples from the province of Shimotsuke, near Nikko, and from Chitose, in Iburi, Hokkaido, the latter received from the Sapporo Museum.

3. ORTHRIAS Jordan and Fowler.

Orthrias JORDAN and FOWLER, new genus (*oreas*).

Allied to *Nemacheilus* Van Hasselt.

Body elongate and compressed. Head sometimes depressed, and with the dorsal profile nearly horizontal; no spine below eye; mouth small, inferior, and with fleshy lips; barbels 6, none on the mandible. Dorsal fin short, and situated over the ventrals. Ventral rays 8. Air bladder more or less inclosed in a bony capsule. Caudal rounded or truncate, not forked. Lateral line complete. Fresh waters of Eastern Asia, the species apparently numerous.

This genus is related to *Nemacheilus*, but the original type of that group (*N. fasciatus*) has about 13 dorsal rays and the caudal forked. The Japanese species with a short dorsal and a truncate caudal is therefore made the type of a distinct genus, *Orthrias*, to which numerous Chinese and other Asiatic species apparently also belong.

(ὀρθριός, of the dawn; hence Japanese.)

4. ORTHRIAS OREAS Jordan and Fowler, new species.

Head $4\frac{3}{4}$ in length; depth 9; D. 10; A. 8; P. 14; V. 8; width of head $1\frac{1}{5}$ in its length; snout $2\frac{1}{2}$ in head; interorbital space 4; eye 2 in snout; pectoral $1\frac{1}{4}$ in head; ventral $1\frac{2}{5}$.

Body moderately elongate and compressed, the tail compressed. Head elongate, broad, depressed; snout long, blunt, obtusely rounded and produced; eyes small, a little anterior and superior; mouth small, inferior and with thick fleshy lips; barbels 6, none on the mandible, and the maxillary pair the longest; nostrils close together and in front of the eye, and the anterior in a small tube; interorbital space like the top of the head, broad and slightly convex. Gill-openings lateral, and the membranes joined below the base of the pectoral in front.

Scales minute, and embedded in the skin; head apparently naked.

Origin of the dorsal midway between the tip of the snout and the base of the caudal; the height of the dorsal is greater than the depth of the body, and when depressed its length is only a little less than that of the head; anal entirely behind the dorsal, and reaching more than half the space between its own origin and the base of the caudal; caudal about equal to the depressed dorsal, truncate, its margin straight, and with sharp corners; pectorals rather long, three-fourths the length of the head, and halfway in the space between their own origins and those of the ventrals; ventrals below and just a trifle behind the origin of the dorsal, and reaching more than halfway in the space between their own origins and that of the anal. Caudal peduncle long, compressed, its length about equal to the pectoral and its least depth about $2\frac{1}{2}$ in the head. Lateral line continuous, median along the sides.

Color in alcohol pale brown above, with about 15 large blotches of deep brown; a dark streak from eye to tip of snout; head finely mottled with dark brown above; dorsal and caudal whitish, with broad,

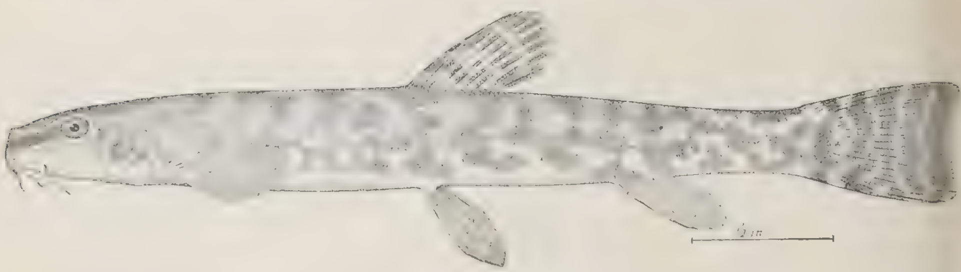


Fig. 2.—Orthrias oreas.

deep, brownish cross bars; pectorals, anal and ventrals whitish, with dusky blotches, indistinct on the latter fins; lower surface on the head and trunk whitish.

Length $3\frac{7}{16}$ inches.

Type, a specimen in the museum at Sapparo, kindly loaned to us by Mr. S. Nozawa. Locality, Chitose, in Iburi, a province of Hokkaido. This specimen, received from the Sapporo Museum, is the only example of the species we have seen.

(*ὄρειας*, of the hills.)

4. COBITIS (Artedi) Linnæus.

Cobitis Artedi, Genera, 1738 (nonbinomial).
Cobitis Linnæus, Syst. Nat., 10th ed., 1758, p. 303 (*tænia*).
Acanthopsis Agassiz, Mém. Soc. Sci. Nat. Neuchâtel, I, p. 36 (*tænia*, not of Van Hasselt, 1823).

Body elongate, more or less compressed, and the back not arched. Head elongate, compressed; eyes small; snout produced, blunt and rounded; mouth small, inferior, and with six barbels about the upper

jaw; below the eye, an erectile bifid spine. Dorsal fin about over the ventrals; anal behind dorsal; caudal rounded or truncate; pectorals less than the head; ventrals below dorsal. Air-bladder inclosed in a bony capsule. Lateral line incomplete. Small fresh-water fishes of Europe and Asia. Probably all the species described will be referred to the widely distributed and variable form described below.

(*cobitis*, a loach.)

5. COBITIS TÆNIA Linnæus.

TAKANOHADOJO (HAWK-WING LOACH), SHIMADOJO (STRIPED LOACH).

Cobitis tænia LINNÆUS, Syst. Nat., 10th ed., 1758, p. 303; Europe.—CUVIER and VALENCIENNES, Hist. Poiss., XVIII, 1846, p. 58.—GÜNTHER, Cat. Fish., VII, 1868, p. 362; Holland, Bavaria, Sweden, and of authors generally.

Cobitis tænia japonica SCHLEGEL, Fauna Japonica, Poiss., p. 222, pl. CIII, fig. 3, 1846; near Nagasaki (not *Cobitis japonica* Houttuyn).

Cobitis caspia EICHWALD, Bull. Soc. Nat. Mosc., 1838, p. 133; near Caspian Sea.

Cobitis elongata HECKEL and KNER, Süssenwasserfische Oester., 1858, pp. 164, 305; Austria.

Cobitis larvata DE FILIPPI, Mem. Accad. Torin., XIX, p. 71; Italy.

Cobitis sinensis SAUVAGE and DE THIERSANT, Ann. Sci. Nat., (6) 1875, I, p. 8; Setchuan, China.—FOWLER, Proc. Acad. Nat. Sci. Phila., 1899, p. 182.

Cobitis biwæ JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1901, p. 748; Lake Biwa, substitute for *Cobitis japonica*, preoccupied.

Head $4\frac{3}{4}$ in length; depth $5\frac{1}{3}$; D. 8; A. 7; P. 10; V. 8; width of head, a little over 2 in its length; snout $2\frac{1}{4}$ in head; pectoral $1\frac{1}{2}$; ventrals $1\frac{2}{3}$; eye $5\frac{2}{3}$; interorbital space $5\frac{2}{3}$.

Body elongate, compressed. Head elongate, much compressed, and with the upper profile convex; snout long, produced, and bluntly rounded; eyes small, superior, lateral, and nearer the tip of the snout than the gill-opening; mouth small, inferior, and with fleshy lips, the lower divided and with two lobes; barbels 8, two of which are mandibulars; nostrils nearer the eye than the tip of the snout, close together, and the anterior pair in a short tube; interorbital space narrow, about equal to the eye and convex. Gill-openings large, lateral, and the gill-membrane joined below the base of the pectoral in front.

Scales very small on the trunk, none on the head.

Origin of the dorsal nearer the base of the caudal than the tip of the snout and a little in front of the ventrals; length of dorsal when depressed a little less than the length of the head and the height of the fin much less than the greatest depth of the body; anal entirely behind dorsal and reaching two-thirds the space between its origin and the base of caudal; caudal equal to depressed dorsal, and rounded; pectoral $1\frac{2}{3}$ in head, and $2\frac{1}{3}$ in the space between its own origin and that of the ventral; ventrals 2 in the space between their own origins and that of the anal. Caudal peduncle compressed, its length equal to the pectoral, and its depth a little less than 2 in the head. Lateral line short, only running a little beyond the middle of the pectoral.

Color in alcohol pale brownish, dark above, and the sides with two rows of dark blotches, those in the lower row large, and between the two rows a narrow paler marbled brown streak; 6 blotches of dark brown between occiput and origin of dorsal, and 7 more between the latter and the base of caudal; base of caudal above with a jet-black spot; dorsal and caudal barred broadly with blackish brown; head marbled and spotted with brown above, and a blackish streak from eye to snout; lower surface of the body, pectorals, ventrals, and anal, pale or whitish.

Length $3\frac{13}{16}$ inches.

This description from an example from Kawatana, on Omura Bay.

Fresh waters of Japan; our very numerous series from Aomori, Kitakami River, lake near Sendai (collection Awano), Niigata in Echigo (collection Eitaro Iijima), Tamagawa in Tachikawa, Kinu River, in Utsunomiya, Iwai River in Ichinoseki, Tokyo, Tsuruga, Nagoya in Owari (collection K. Otaki), Yodo River at Osaka, Chikugo River at Kurume, Kawatana, and Lake Biwa.

In this series great variation occurs. The examples from Lake Biwa are very much more elongate and have the brown blotches on the sides merged into a continuous longitudinal band, and the space between it and the superior dorsal row of spots, which is also more or less continuous, light and plain colored, like the lower surface of the body. The colors are altogether more distinct and sharply defined, and the dorsal and caudal are with only one or two blackish bars. This form has been described from near Nagasaki under the name of "*Cobitis tænia japonica*" by Schlegel. As the name *japonica* is preoccupied in *Cobitis*, Jordan and Snyder have substituted for it the name of *Cobitis biwæ*. But there seems to be no permanent value in these differences in color and form. Examples from Kawatana and the Chikugo River at Kurume, collected together in both localities, contain both this striped form and those with the lateral bands broken up into spots.

We can not find any difference between the Japanese species and the Loach of Europe, and hence retain for it the ancient name of *Cobitis tænia*. Should the Asiatic species prove distinct, the name *Cobitis sinensis* may be retained for it.

(*ταινία*, ribbon.)

5. HYMENOPHYSA McClelland.

Hymenophysa McClelland, Indian Cyprinidæ, 1838, p. 443 (*hymenophysa*).
Syncrossus Blyth, Journ. Asiat. Soc. Bengal, 1860, p. 166 (*berdmorei*).

Body short, deep, and compressed. Head elongate, compressed, and pointed, the snout long, pointed and its tip bluntly rounded; eyes small; mouth inferior and with fleshy lips; barbels 6, the maxillary pair long, and the others close together at the tip of the snout;

no mental barbels; a strong bifid spine below the eye in front. Gill-openings lateral. Scales very small. Dorsal inserted in advance of the origin of the ventral; caudal deeply forked. Air-vessel consisting of two divisions, an anterior inclosed in a partly osseus capsule and a posterior which is free in the abdominal cavity.

This genus differs from *Botia* (= *Schistura* = *Diacantha*) in the presence of but six barbels instead of eight.

(*ὑμήν*, membrane; *φυδός*, swollen.)

6. HYMENOPHYSA CURTA (Schlegel).

AYAMADOKI; AYABATA.

Corbitis curta SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 223, pl. CXII, fig. 4; near Nagasaki.

Botia curta GÜNTHER, Cat. Fish., VII, 1868, p. 368 (after Schlegel).

Head 4 in length; depth $4\frac{3}{4}$; D. 12; A. 9; P. 14; V. 8; scales 130; width of head $2\frac{1}{2}$ in its length; snout $2\frac{2}{3}$ in the head; pectoral 1[illegible]; ventral $1\frac{3}{4}$; eyes $2\frac{1}{2}$ in snout; $1\frac{1}{3}$ in interobital space.

Body oblong, rather deep and compressed. Head oblong, compressed and pointed in front; snout long, pointed, and compressed, the tip bluntly rounded and slightly projecting beyond the mouth; eyes moderate, anterior, superior and with the eyelid freely circular; mouth small, inferior, and with fleshy lips; barbels 6, the maxillary pair reaching the eyes, and the remaining 4 are close together at the tip of the snout; nostrils close together, a little nearer the eye than the tip of the snout, and the anterior pair in a short tube; interorbital space convex. Gill-openings large, lateral.

Body and sides of the head covered with very small cycloid scales.

Origin of the dorsal about midway between the tip of snout and base of caudal, its height about equal to the length of the pectoral; anal entirely behind dorsal and reaching about two-thirds in the space between its own origin and the base of the caudal; caudal nearly equal to the length of the head, deeply forked and the lobes pointed; pectorals narrow, lobate, nearly two-thirds the length of the head, and equal to about half the distance between their own origins and those of the ventrals; ventrals behind the origin of the dorsal, and their tips not reaching as far as the tip of the depressed dorsal, or about two-thirds the space between their own origins and that of the anal. Caudal peduncle very deep, compressed, its length about equal to the ventral and its depth a trifle more but not equal to the length of the pectoral. Lateral line straight along the sides to the base of the caudal.

Color in alcohol more or less uniform brown, the back slightly darker; anterior edge of dorsal blackish-brown, and the fin with an indistinctly defined broad brown cross-bar; anal with a brown cross-bar, and two on each caudal lobe.

Length, $5\frac{13}{16}$ inches.

Described from a specimen taken at Kibama, Japan, near Lake Biwa; our specimens all from Kibama, in Omi, presented by the Imperial University at Tokyo.

(*curtus*, short.)

SUMMARY.

Family Cobitidæ.

1. *Misgurnus* Lacépède.

1. *polynemus* (Bleeker).
2. *anguillicaudatus* (Cantor); Junsai Lake in Aomori, Hakodate, Tsuchiura, Niigata, Sendai, Yodo River at Osaki, Iwai River at Ichinoseki, Morioka, Misaki, Tokyo, Nagasaki, Formosa.

2. *Elxis* Jordan and Fowler.

3. *nikkonis* Jordan and Fowler; Shimotsuke, near Nikko, Chitose in Iburi.

3. *Orthrias* Jordan and Fowler.

4. *oreas* Jordan and Fowler; Chitose in Iburi.

4. *Cobitis* Linnæus.

5. *tænia* Linnæus; Aomori, Kitakami River at Sendai, Niigata, Nagoya, Yodo River, Lake Biwa, Chikugo River at Kurume.

5. *Hymenophysa* McClelland.

6. *curta* (Schlegel); Kibama in Omi.

NOTES ON ORTHOPTERA FROM COLORADO, NEW MEXICO, ARIZONA, AND TEXAS, WITH DESCRIPTIONS OF NEW SPECIES.

By Andrew Nelson Caudell,

Of the Department of Agriculture.

The following paper deals with three separate collections: (1) a large collection from Colorado, including a few from just across the line in New Mexico, made by Dr. H. G. Dyar and myself during the months of May, June, July, and August, 1901; (2) a small collection made in Arizona, mostly at Williams and Hot Springs, by Messrs. Schwarz and Barber during the summer of 1901; and (3) a small collection made by the writer in Texas in June and July, 1902. This material forms part of the collection of the U. S. National Museum.

The Colorado collection, which furnishes material for the greater part of this paper, but partially confirms the result reached by Dr. Dyar regarding the life zones of that State as recently described by him[a]—that is, that there are four faunal regions in Colorado: prairie, foothill, alpine, and western slope. The orthopterous fauna indicate the first three zones only, which are in most cases quite sharply defined, but there are a number of species that occur in two or more of the zones. The line between the prairie and the foothill faunas is exceedingly well defined at some places, while at other places the transition from one to the other is more gradual.

The primary aim of the Colorado expedition was to work out the life history of Lepidoptera, and not to collect Orthoptera, and in consequence it was not possible to visit all parts of the State. Therefore the range worked over is not extensive and does not include places inaccessible by rail. A few specimens from Middle Park were purchased from E. J. Oslar, a professional collector of Denver, and are included in this paper.

The various localities visited by the writer in Colorado, their altitude, location, and notes on the vicinity are given in the following alphabetical list:

Baileys, Park County; altitude, 7,714 feet.—This place is some miles up the Platte canyon. One day only was spent there and but nine species of Orthoptera were taken.

[a] Proc. U. S. Nat. Mus., XXV, 1902, p. 369.

Boulder, Boulder County; altitude, 5,335 feet. Two trips were made to this place and a little collecting done in and along the base of the foothills just back of the town. Insects were not at all numerous at the time the visits were made and but five species of Orthoptera were taken.

Chama, Rio Arriba County, New Mexico; altitude, 7,863 feet.—Half an hour only was spent here, six species being taken, of which *Dissosteira carolina* was the most common.

Chimney Gulch.—See Golden.

Cripplecreek, Teller County; altitude, 9,396 feet.—Half a day was spent at this interesting locality out near the Golden King gold mine. *Circotettix undulata* was the common species.

Cumbres, Conejos County; altitude, 10,015 feet.—One hour of profitable collecting was put in here when it began to rain, and a wet afternoon was utilized in riding down the western slope of the mountains on a freight car rather than wait in a section house for the passenger train next day. Five species only were taken, all alpine forms, one of them a new species.

Delta, Delta County; altitude, 4,980 feet.—Several hours were spent across the river from this place, mostly in investigating garden insects. Two species of *Eoloplus* were taken. At this place some damage was threatened by *Melanoplus differentialis.*

Denver, Arapahoe County; altitude, 5,198 feet.—Most of the collecting in the vicinity of Denver was done in two localities, one south of the city, on the prairie just beyond the city park, and the other on the opposite side of the city. Nearly forty species and many specimens were taken here.

Durango, La Plata County; altitude, 6,520 feet.—A few hours were spent collecting north and east of this town. The limited time prevented the discovery of the excellent collecting grounds said by Mr. Oslar to exist in that vicinity.

Fort Collins, Larimer County; altitude, 4,972 feet.—Two visits were made to this productive locality and many desirable specimens taken, mostly north and west of town. No opportunity presented itself to go up into the neighboring foothills, and the specimens taken were therefore all prairie forms, or ones common to two or more faunal regions. One species only, *Eremopedes balli*, may be considered as belonging strictly to the foothill fauna. Forty-eight species were taken at this place.

Glenwood Springs, Garfield County; altitude, 5,758 feet.—Three stops were made at this place, but little collecting was done. A few specimens were taken out east of town a half mile or so and also a few in town near the station. But seven species were taken, of which four belong to the genus *Melanoplus.*

Golden, Jefferson County; altitude, 5,667 feet.—This is a good collecting ground and very accessible from Denver, being about 13 miles

west of there near the foothills. The collecting was done on the prairie between the town and the foothills, less than a quarter of a mile in width, and up the canyon known as Chimney Gulch to the top, about a thousand feet higher. Over fifty species were collected at this locality. The prairie and foothill faunas are here quite distinctly and abruptly divided.

Grand Junction, Mesa County; altitude, 4,594 feet.—Two stops of short duration were made here. The collecting was done northeast of town and also in town just across the railroad from the station, where many fine specimens of *Melanoplus differentialis* were taken.

Mancos, Montezuma County; altitude, 7,008 feet.—Two species were taken near the station while the train stopped, *Melanoplus femur rubrum* and *Stenobothrus curtipennis*.

Montevista, Rio Grande County; altitude, 7,665 feet.—A bicycle trip several miles out of town was taken August 13. Insect life of all kinds was very scarce and but nine species of Orthoptera were taken, the most desirable one of which was probably *Nemobius utahensis*.

Montrose, Montrose County; altitude, 5,811 feet.—Half an hour's collecting in the vicinity of the station resulted in the capture of nearly a dozen species.

Morrison, Jefferson County; altitude, 5,753 feet.—Several visits were made here. Just south of the station, across the creek beyond and to the right of the schoolhouse, grasshoppers were found to abound in countless numbers. Collecting trips were made to and beyond the picturesque red sandstone formations northwest of town and up the canyon into the foothills. But two species were collected in the foothills, however, *Trimerotropis similis* and *Gomphocerus clavatus*. The bulk of the specimens taken on the prairie at this place was *Melanoplus occidentalis*.

Palisade, Mesa County; altitude, 4,741 feet.—At this little town, 12 miles from Grand Junction, *Eoloplus chenopodii* was taken in considerable numbers on the plants just across the railroad from the station. A few other species, including a new species, were taken in the immediate vicinity.

Pikes Peak, El Paso County; altitude, 8,913 feet.—A day was spent here and the ascent of the peak made.[a] The above altitude is that of the halfway house, and it is to that locality which all the Pikes Peak labels refer unless otherwise specified.

Pine Grove, Park County; altitude, 6,738 feet.—This is a small resort some miles up Platte Canyon, and there a couple of days were spent collecting along the railroad and up a side canyon for a mile or so, leading up probably a thousand feet above the town. A dozen species were taken here, mostly true foothill forms.

Platte Canyon, Douglas County; altitude, 5,492 feet.—Numerous trips were made to this place, which is but a station at the mouth of

[a] See account in Proc. Ent. Soc. Wash., V, 1902, pp. 74–82.

Platte Canyon. Collecting was done up the canyon as far as a small side gulch known as Mill Gulch, and up that gulch for more than a mile, as well as up other gulches for lesser distances. But most of the Orthoptera were taken near the mouth of the canyon. But ten species were taken here.

Rico, Dolores County; altitude, 8,737 feet.—Insects were very scarce here, two hours' collecting resulting in but three species of Orthoptera and practically nothing else. The Orthoptera were all alpine forms.

Salida, Chaffee County; altitude, 7,050 feet.—Two weeks were spent here, including a couple of visits. Other duties prevented much time being devoted to collecting Orthoptera, and nearly every afternoon it rained, but still quite a number of good things were taken. By far the most productive locality was the side of the large hill, called Tenderfoot Mountain, just across the railroad from the station. Here *Æoloplus plagosus* and *Derotmema haydeni* occurred in numbers. *Leprus cyaneus* was also taken here, though not so numerous and usually some distance farther up the hill.

Sedalia, Douglas County; altitude, 5,835 feet.—This small town is a few miles south of Denver, and is in a broad valley formed by the foothills on the west and high mesas on the east. Collecting was done across the entire valley, but only eleven species were taken.

At the above localities over a hundred species of Orthoptera were taken and the collections from Arizona and Texas bring the number up to one hundred and fifty-four. All are here mentioned, even if only for the value attached to record of exact locality, but many of the species are represented by a considerable number of specimens and thus usually furnish some notes of value on variation or distribution.

Family BLATTIDÆ.

1. PHYLLODROMIA GERMANICA Linnæus.

Blatta germanica LINNÆUS, Syst. Nat., 12th ed., II, 1767, p. 688.

One nymph of this species was taken at Glenwood Springs on August 18.

2. BLATTA ORIENTALIS Linnæus.

Blatta orientalis LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 424.

Two specimens, both males, one at Denver and one at Pueblo in August, the latter by E. J. Oslar.

3. ISCHNOPTERA UHLERIANA Saussure.

Ischnoptera uhleriana SAUSSURE, Rev. Mag. Zool., XIV, 1862, p. 169.

One specimen at Victoria, Texas, in June.

4. PERIPLANETA AMERICANA Linnæus.

Blatta americana LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 424.

This insect is very common in southern Texas, indeed amounting to a veritable pest. It comes into the houses through the open windows and but for the ever-present canopy of netting over the beds in that part of the country would very probably establish itself as an unwelcome and very uncomfortable spiny bedfellow. Happily the netting prevents this, but unhappily the *Acantha lectularia* is not so easily excluded.

A razor case left for a couple of weeks in a drawer in one of Victoria's leading hotels, had the covering nearly all eaten off by this large roach. The ordinary house species, *Phyllodromia germanica* and *Blatta orientalis*, do not appear to be common in localities where this species thrives.

5. PERIPLANETA TRUNCATA Krauss.

Periplaneta truncata KRAUSS, Zool. Anzeiger, XV, 1892, p. 165.—SAUSSURE and ZEHNTNER, Biol. Cent. Amer. Orth., I, 1893, p. 74.

Two female specimens of this species were collected in the laboratory of the boll weevil investigation at Victoria, Texas, in the early part of July, 1902. This is a new insect to the United States, but there can be but little doubt of the correctness of the identification. It is the variety "a" of Saussure and Zehntner.

6. HOMŒOGAMIA APACHA Saussure.

Homœogamia apacha SAUSSURE, Rev. Suisse de Zool., I, 1893, p. 396.

The collection of the U. S. National Museum contains specimens of this species from Texas, Colorado, Arizona, and California. This is the first record of this species from the United States, though it seems to be not at all rare. *Homœogamia subdiaphana* Scudder seems somewhat allied to this species, but Mr. Rehn, who has taken *subdiaphana* in New Mexico, says they are distinct.

Family MANTIDÆ.

7. YERSINIA SOLITARIA Scudder.

Yersinia solitaria SCUDDER, Can. Ent., XXVIII, 1896, p. 209.

Two immature specimens of this species were taken, one at Fort Collins and one at Golden, the former on August 9 and the latter on July 17.

8. LITANEUTRIA MINOR Scudder.

Stagmatoptera minor Scudder, Rept. U. S. Geol. Surv. Nebr., 1871, p. 251.

Females of what I take for this species were taken at Golden and Fort Collins in August. The greedy habits of this species were recently noted.[a]

Family PHASMIDÆ.

9. DIAPHEROMERA DENTRICUS Stål.

Diapheromera dentricus Stål, Rec. Orth., III, 1875, p. 76.

One male, June 21, at Victoria, Texas. This specimen was on weeds by the roadside. Mr. Mitchell tells me that this fine large walking stick is not uncommon at times on grape vines in the river bottoms.

Family ACRIDIIDÆ.

Subfamily TETTIGINÆ.

10. TETTIX CRASSUS Morse.

Tettix crassus Morse, Journ. N. Y. Ent. Soc., VII, 1899, p. 201.

Two specimens of what Professor Morse thinks is probably this species were taken at Platte Canyon on May 10. The median carina of the thorax is marked with white, strongly contrasted with the rest of the insect.

11. TETTIX INCURVATUS Hancock.

Tettix incurvatus Hancock, Amer. Nat., XXIX, 1895, pp. 761–762, fig. 1.

Five specimens, Platte Canyon May 10, in company with *T. crassus*. Dr. Hancock verified this determination.

12. PARATETTIX CUCULLATUS Burmeister.

Tetrix cucullatus Burmeister, Handb. Ent., II, 1838, pp. 658–659.

One female at Fort Collins August 11. Professor Morse examined this specimen and pronounced the determination correct.

Subfamily TRYXALINÆ.

13. MERMIRIA TEXANA Bruner.

Mermiria texana Bruner, Proc. U. S. Nat. Mus., XII, 1890, pp. 53–54, pl. I, fig. 11.

One pair at Fort Collins on August 9, and one male nymph, which is probably of this species, at Salida on August 2.

[a] Ent. News, XIII, 1902, p. 60.

14. SYRBULA ADMIRABILIS Uhler.

Stenobothrus admirabilis UHLER, Proc. Ent. Soc. Philad., II, 1864, p. 553.

Both mature and immature specimens of both sexes taken at Victoria in June and July.

15. ACROLOPHITUS HIRTIPES Say.

Gryllus hirtipes SAY, Amer. Ent., III, 1828, p. 78, pl. XXXIV.

The "green fool," as Dr. Dyar and I christened this handsome insect, is very common along the eastern foothills, more than a hundred being taken, mostly at Golden. Young nymphs were taken early in May, and mature individuals began to appear about the middle of July.

16. ERITETTIX NAVICULA Scudder.

Gomphocerus navicula SCUDDER, Ann. Rept. Chief Eng., 1876, p. 506.

Three males, seven females, Sedalia June 12; Denver May 7; Boulder May 27; Golden June 5. One of the females taken at Golden on June 5 is placed here with some hesitation. It is remarkable in having the pronotum uniformly fuscous dorsally and without a trace of supplementary carinæ on the pronotum, though they are present on the head and diverge anteriorly to meet the raised margins of the vertex. The upper half of the lateral lobes of the pronotum is piceous, a coloration unlike any other specimen of any species of this genus that I have seen. The original description of *navicula* offers no distinguishing features to separate it from *E. tricarinatus*, which was described from the female sex alone. In fact, the females of the two species, as I have them determined in the collection of the U. S. National Museum, are inseparable, but the males are very readily distinguished, those of *navicula* having the antennæ gradually enlarged, the club composing about one-third of the entire length, while in *tricarinatus* the enlargement of the antennæ is abrupt, the club composing no more than one-sixth of the entire length. The Museum contains specimens of *navicula* from Wyoming and Colorado in considerable numbers. *Tricarinatus* does not appear to occur in Colorado, all the Museum material being from Wyoming, Montana, and the Dakotas.

17. AMPHITORNUS BICOLOR Thomas.

Stenobothrus bicolor THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 465.

Three males, eight females, Golden June 6 to 27; Fort Collins August 9 and 11; Denver July 7 and 16.

18. OPEIA OBSCURA Thomas.

Oxycoryphus obscura THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1871, p. 466.

One male, eleven females, Golden August 21; Fort Collins August 10.

19. CORDILLACRIS CINEREA Bruner.

Ochrilidea cinerea Bruner, Proc. U. S. Nat. Mus., XII, 1890, pp. 52–53.

Three males, one female, Salida August 21; Morrison June 25.

20. CORDILLACRIS CRENULATA Bruner.

Ochrilidea crenulata Bruner, Proc. U. S. Nat. Mus., XII, 1890, pp. 51–52.

Five males, two females, Montevista August 13; Morrison June 29; Denver July 16.

21. CORDILLACRIS OCCIPITALIS Thomas.

Stenobothrus occipitalis Thomas, Rept. U. S. Geol. Surv. Terr., V, 1873, p. 81.

Fourteen males, eleven females, Morrison June 23; Fort Collins August 9 and 11; Denver July 17.

22. PHLIBOSTROMA QUADRIMACULATUM Thomas.

Stenobothrus quadrimaculatum Thomas, Ann. Rept. U. S. Geol. Surv. Terr., II, 1871, pp. 166, 280.

Thirty-seven males, forty-four females, Golden July 12 to August 21.

23. ORPHULELLA PELIDNA Burmeister.

Gomphocerus pelidna Burmeister, Handb. Ent., II, 1838, p. 650.

One male at Victoria, Texas, in June, 1902, and two males from widely separated localities in Colorado, one from Grand Junction on August 17 and one from Fort Collins on August 10. The specimen from Texas is a little over the usual size, measuring as follows: Length of body, 20.5 mm.; elytra, 18 mm.; hind femora, 12 mm.

The larger males of this species superficially resemble the dark form of the males of *Syrbula admirabilis* very closely.

24. ORPHULELLA PICTURATA Scudder.

Orphulella picturata Scudder, Can. Ent., XXXI, 1899, pp. 178, 182.

Many specimens of both sexes collected at Victoria, Texas, in June and July, some of them taken in cotton fields. This is a very variable species and there are both green and brown forms.

25. ORPHULELLA SALINA Scudder.

Orphulella salina Scudder, Can. Ent., XXXI, 1899, pp. 179, 185–186.

Two specimens from Colorado, one male at Montrose on August 17, and one female at Grand Junction on July 7.

26. DICHROMORPHA VIRIDIS Scudder.

Chloealtis viridis SCUDDER, Bost. Journ. Nat. Hist., VII, 1862, p. 455.
Chloealtis brunnea SCUDDER, Proc. Bost. Soc. Nat. Hist., XVII, 1875, p. 510.

Both sexes of this species, together with the nymphs, were found plentiful at Victoria, Texas, in June and July. This species varies in the character of the lateral carinæ of the pronotum, some having the carinæ parallel and others quite noticeably bowed out in the center, both forms occurring together. One specimen before me from Florida has the vertex abnormally acute. I have carefully studied the type of *brunnea* in the Museum collection and compared it with brown forms of *viridis* and find no appreciable difference not covered by variation. I have therefore included it as a synonym.

27. STENOBOTHRUS CURTIPENNIS Harris.

Locusta curtipennis HARRIS, Cat. Ins. Mass., 1835, p. 56.

One female at Montevista on August 13, one at Mancos on August 16, and one male and two female specimens from Cumbres on August 14. The females from Cumbres have the elytra very short, but little more than half as long as the abdomen.

28. GOMPHOCERUS CLAVATUS Thomas.

Gomphocerus clavatus THOMAS, Rept. U. S. Geol. Surv. Terr., V, 1873, p. 96.
Gomphocerus carpenterii THOMAS, Bull. U. S. Geol. Surv. Terr., I, No. 2, ser. 1874, p. 65.
Gomphocerus clepsydra SCUDDER, Daws., Rept. Geol., 49 Par., 1875, p. 344.

Fourteen males and 17 females from the following points in Colorado: Baileys June 30 and July 3; Morrison on June 20, at an elevation of about 7,000 feet; Boulder June 9; Rico August 16; Pine Grove July 18; Pikes Peak July 21; and at Chimney Gulch on July 21.

From a study of these specimens and a long series in the United States National Museum, it seems very clear that there is but one species. There is considerable variation among the different individuals, especially the males, but no characters present themselves that warrant the retention of more than one name. McNeill, in his revision of the Tryxaninæ, recognizes two species and gives a table for their separation, using the character of the anterior tibiæ being clavate and distinctly sulcate externally and size small, about 14 mm., to separate *clavatus* from *clypsedra*, which is described as having the fore tibiæ but slightly and regularly expanded apically and size larger, about 18 mm. With these characters in mind I carefully examined the type material in the collection of the United States National Museum, which is composed wholly of male specimens. The type of *clavatus* is 16.5 mm. long and the anterior tibiæ is moderately

expanded, not distinctly clavate, and is very distinctly sulcate externally, but this sulcation is quite obviously due to shrinkage as the left tibiæ is more conspicuously sulcate than the right one. Such shrinkage is not remarkable as the specimen was alcoholic and described after drying. The describer gives the length as 0.56 inch in length, which is practically 14 mm But, as above stated, the type really measures 16.5 mm. in length. Why Thomas gave this erroneous measurement is not clear, nor is it clear why McNeill used it as a synoptic character when he had the original type before him.

The type of *carpenterii*, which is an admitted synonym of *clavatus*, is 18 mm. in length, the fore tibiæ strongly clavate and not at all sulcate externally. The type of *clypsedra* is not at present in the United States National Museum as mentioned by McNeill, nor is the original type a male from New Mexico, but females from farther north on the Souris River.

The range of variation presented by the types of *clavatus* and *carpenterii* more than covers all variation found among the specimens of *clepsydra*. Therefore if *clavatus* and *carpenterii* are synonymous, and I agree with McNeill in so considering them, *clypsedra* must also be a synonym. That this is a valid conclusion is pretty evident when a long series of specimens from different parts of the country and from various altitudes is examined. The anterior tibiæ of the males vary considerably in the amount of apical expansion, though none examined are quite so conspicuously clavate as in the type of *carpenterii*. The elytra of the males are also variable, reaching quite to the tip of the abdomen in some specimens and in others falling noticeably short of it. The elytra of the females also vary in length, but never nearly reach the tip of the abdomen, generally only about as long as the pronotum.

29. BOOPEDON NUBILUM Say.

Gryllus nubilus SAY, Journ. Acad. Nat. Sci. Philad., IV, 1825, p. 308.

This species was found quite abundant in open woodlands in the vicinity of Victoria, Texas, during the latter part of June and in July. Only mature individuals were seen.

30. STIRAPLEURA DECUSSATA Scudder.

Stirapleura decussata SCUDDER, Ann. Rept. Chief Eng., 1876, p. 510.

Nine males, 15 females, Golden May 29; Sedalia June 15 and 21 Denver May 10 to July 16; Baileys July 13; Boulder June 9.

The foveolæ of this species, according to McNeill's tables in his revision of the Tryxalinæ, are as long again as wide. Therefore these specimens could be called *delicatula* as justifiably as they are called *decussata* for the foveolæ are usually but little longer than wide *Decussata* and *delicatula* may prove to be forms of one species.

31. AGENEOTETTIX SCUDDERI Bruner.

Aulocara scudderi Bruner, Proc. U. S. Nat. Mus., XIII, 1890, pp. 63–64.

Sixteen males, twenty-eight females, Golden June 19 to July 27; Denver July 16; Fort Collins August 10; Cripple Creek July 26; Montrose August 17.

32. AULOCARA ELLIOTTI Thomas.

Stauronotus elliotti Thomas, Proc. Acad. Nat. Sci. Philad., 1870, p. 82.

Sixty nine males, sixty females, Denver July 16; Morrison July 18; Fort Collins August 10; Golden June 19; Durango August 15; Glenwood Springs July 5; also two apparently full grown female nymphs at Golden on June 19.

This large series of fresh specimens shows a remarkable range of variation, both sexes varying greatly both in color and size. The females are more variable in color while the greatest variation in size occurs in the opposite sex. The posterior femora vary from 10 to 14 millimeters in the males and in the females the color ranges from reddish yellow to fuscous and the elytra of both sexes vary from almost immaculate to quite conspicuously spotted with black. Some of the rufous tinted females approach *parallelum* somewhat, inasmuch as the lateral carinæ of the thorax do not seem quite so much constricted mesially as usual and the disk of the pronotum is unicolorous.

33. AULOCARA FEMORATUM Scudder.

Aulocara femoratum Scudder, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 54, 55–56.

Four males and eight females referable to this species were taken at Fort Collins on August 19 and one pair at Denver on July 11; the latter were taken *in copula*. They all agree in having the elytra much more abbreviated than in *elliotti* and the pronotum is more generally less angulate. The tegmina of the males are immaculate but those of the females are noticeably spotted with black, sometimes however quite dimly so.

SUBFAMILY ŒDIPODINÆ.

34. ARPHIA ARCTA Scudder.

Arphia Arcta Scudder, Bull. U. S. Geol. Surv. Terr., II, 1876, p. 263.
Arphia teporata Scudder, Ann. Rept. Chief Eng., 1876, p. 508.

Eleven males, seven females, Golden May 23; Pine Grove July 8 and 18; Baileys July 13; Platte Canyon May 10; Sedalia June 15; Denver May 10. Also collected at Williams, Arizona, on May 27, and June 9. The color of the hind tibial vary in color from clear yellow to blue.

I feel quite sure of the correctness of the above synonomy, and am inclined to believe that *A. frigida* is but a red-winged form of the same species. The type of *teporata* has yellow wings.

35. ARPHIA LUTEOLA Scudder.

Arphia luteola SCUDDER, Proc. Bost. Soc. Nat. Hist., XVII, 1875, p. 515.

Quite common in cotton fields about Victoria, Texas.

36. ARPHIA PSEUDONIETANA Thomas.

Tomonotus pseudonietana THOMAS, Proc. Acad. Nat. Sci. Philad., 1870, p. 82.
Oedipoda tenebrosa SCUDDER, Rept. U. S. Geol. Surv. Nebr., 1871, p. 251.
Tomonotus tenebrosa THOMAS, Rept. U. S. Geol. Surv. Terr., V, 1873, p. 107.
Arphia sanguinaria STÅL, Rec. Orth., I, 1873, p. 119.
Arphia ovaticeps SAUSSURE, Add. Prodr. Oedip., 1888, pp. 165–166.

Sixteen males, nine females, Denver July 16; Golden June 19 to August 21; Fort Collins August 10.

From a study of this series of specmens and as many more in the collection of the U. S. National Museum I have decided upon the above synonomy, believing the changes warranted. That *ovaticeps* is but a variety of *tenebrosa* is obvious to anyone who has seen this species in numbers, and that the name *pseudonietana* of Thomas was applied first to the species under consideration and should take precedence over *tenebrosa*, described a year later, also seems clear upon investigation of the original descriptions.

When in motion this is one of our most showy locusts, the bright red wings showing very conspicuously as the insect flies before the collector.

37. ARPHIA FRIGIDA Scudder.

Arphia frigida SCUDDER, Daws., Rep. geol. 49th par., 1875, p. 344.

Forty-one males, five females, Golden May 29 to June 17; Sedalia June 15; Denver May 10 to June 17; Platte Canyon May 10 to 17; Boulder May 22; Morrison June 29.

38. CHORTOPHAGA VIRIDIFASCIATA DeGeer.

Acrydium viridifasciatum DEGEER, Mem., III, 1773, p. 498, pl. XLII, fig. 6.

Both green and brown forms of both sexes occurred quite commonly around Victoria, Texas, in June and July. From specimens observed at this place it would appear that brown individuals occur more often in the male than in the female sex. In Colorado twelve males and eighteen females were taken at Denver, Platte Canyon, and Golden. All these specmens were taken between May 10 and June 10 and were all of the brown form, except four females, and they were partially brown. Some variation exists in the amount of apical swelling of the male antennæ.

39. ENCOPTOLOPHUS COSTALIS Scudder.

Œdipoda costalis SCUDDER, Bost. Journ. Nat. Hist., VII, 1862, p. 473.

Found in cotton fields at Victoria, Texas, in June and July; not numerous. Six males and two females were taken at Fort Collins on August 9, and two males and two females at Golden on August 21.

The males of this species bear quite a superficial resemblance to *Camnula pellucida*, but the reddish yellow tibiæ of the latter will serve to readily separate them. The smaller size, low median carina and, especially in the male, the proportionately broader elytra separate *costalis* from *sordidus*.

40. CAMNULA PELLUCIDA Scudder.

Œdipoda pellucida SCUDDER, Bost. Journ. Nat. Hist., VII, 1862, p. 472.

Sixty-eight males, forty-six females, Cumbres August 14; Montrose August 16; Baileys July 13; Rico August 16; Pikes Peak July 21; Cripple Creek July 26; Chama, New Mexico August 14; Pine Grove July 18.

This is a common insect throughout the elevated regions of Colorado.

41. HIPPISCUS MONTANUS Thomas.

Œdipoda montanus THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 462.

Three males, two females, Denver May 10. Identified by Professor Bruner. Except for the obscured markings this species is very similar to *H. zapotecus*.

42. HIPPISCUS NEGLECTUS Thomas.

Œdipoda neglectus THOMAS, Proc. Acad. Nat. Sc. Philad., 1870, pp. 81–82.

Nineteen males, seven females, Baileys July 13; Chama, New Mexico August 14; Pine Grove July 8; Morrison June 29; Platte Canyon May 25; Chimney Gulch July 27; Pikes Peak July 21.

Three of the males, one from Pikes Peak and two from Baileys, have the posterior tibiæ pale yellowish with scarcely a trace of red.

43. HIPPISCUS SAUSSUREI Scudder.

Hippiscus saussurei SCUDDER, Psyche, VI, 1892, pp. 268, 302.

One female specimen at Victoria, Texas, in June.

44. HIPPISCUS TUBERCULATUS Palisot de Beauvois.

Acridium tuberculatum PALISOT DE BEAUVOIS, Ins. Afr. Amer., 1817, p. 145, pl. IV, fig. i.

One female at Sedalia on June 15.

45. HIPPISCUS ZAPOTECUS Saussure.

Xanthippus zapotecus SAUSSURE, Prodr. Œdip., 1884, p. 91.

Four males, three females, Denver May 10 to June 17. Professor Bruner is the authority for this determination.

46. LEPRUS CYANEUS Cockerell.

Leprus cyaneus COCKERELL, Ent. News, XIII, 1902, p. 305.

Seven males, one female, Salida August 2–9.

The wings of *L. wheeleri* are a bright yellow, as plainly shown by the types. Therefore, the reference of blue-winged specimens to that species, as has so often been done, is erroneous. *L. cyaneus* is a good species.

47. DISSOSTEIRA CAROLINA Linnæus.

Gryllus (*Locusta*) *carolina* LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 433.

Common throughout Colorado, specimens being taken on both sides of the mountains from Denver to Grand Junction.

48. DISSOSTEIRA LONGIPENNIS Thomas.

Œdipoda longipennis THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 463.

One male at Fort Collins August 9. A common species at times and is reported to come quite freely to light at night.

49. SPHARAGEMON ÆQUALE Say.

Gryllus æquale SAY, Journ. Acad. Nat. Sci. Philad., IV, 1825, p. 307.

Four males, three females, Denver July 16; Golden August 21; Fort Collins August 9. The specimens from Denver, two males, are not typical. They were identified by Prof. A. P. Morse. The median carina of the prothorax is somewhat elevated on the pronotum and scarcely at all on the metanotum, which is flat. The change from the elevated prozona to the scarcely carinate metazona is very abrupt. These specimens are also more slender than usual.

50. SPHARAGEMON ANGUSTIPENNE Morse.

Spharagemon angustipenne MORSE, Psyche, VII, 1895, pp. 295, 298.

One female from Denver on July 16.

51. SPHARAGEMON COLLARE Scudder.

Œdipoda collare SCUDDER, Rept. U. S. Geol. Surv., Nebr., 1871, p. 250.

Two females from Golden on June 1.

52. SPHARAGEMON CRISTATUM Scudder.

Spharagemon cristatum Scudder, Proc. Bost. Soc. Nat. Hist., XVII, 1875, p. 470.

Several specimens at Victoria, Tex., in June and July.

53. SPHARAGEMON HUMILE Morse.

Spharagemon humile Morse, Psyche, VII, 1895, p. 292.

Two males, one female, Golden June 18 and August 21.

54. SPHARAGEMON WYOMINGIANUM Thomas.

Œdipoda wyomingianum Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 462.

Three males, Fort Collins August 10; Golden June 18.

55. DEROTMEMA CUPIDINEUM Scudder.

Derotmema cupidineum Scudder, Ann. Rept. Chief Eng., 1876, p. 513.

Five males, six females, Montrose August 17; Grand Junction August 17; Palisades July 8.

Not so common as *D. haydeni*, from which it may be separated by the narrower fuscous bands of the wings.

56. DEROTMEMA HAYDENI Thomas.

Œdipoda haydeni Thomas, Rept. U. S. Geol. Surv. Terr., V, 1871, p. 460.

Thirty-three males, twenty-seven females. Salida August 2 to 6; Montrose August 17; Durango August 15; Denver July 16; Fort Collins August 10; Golden June 19 to August 21; Montevista August 13.

Both red and yellow winged specimens, male and female, were taken. This species is very common in most localities throughout the State. Individuals with yellow wings were the more numerous.

57. MESTOBREGMA BOREALE Saussure.

Psinidia (Trachyrachis) boreale Saussure, Prodr. Œdip., 1884, p. 164.

One female, Golden June 5.

The conspicuous character of this species is the unusually rugose pronotum. The top of the head is marked with several tortuous carinæ and the frontal costa is traversed by a carina just below the ocellus. The wings are yellow at the base and the tip is hyaline; transverse black band a fourth as wide as the length of the wing with the costal shoot extending three-fourths of the way to the base; elytra regularly mottled with quite large fuscous spots. The posterior tibiæ are yellow.

58. MESTOBREGMA FUSCIFRONS Stål.

Psinidia fuscifrons Stål, Rec. Orth., I, 1873, p. 134.

Specimens of this species were collected in cotton fields at Victoria, Texas, in June.

59. MESTOBREGMA KIOWA Thomas.

Œdipoda kiowa THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 461.

Specimens, both mature and immature, were taken on the summit of Pikes Peak on snow fields, and a number of mature individuals of both sexes were taken at the following places in Colorado and New Mexico: Montevista August 13; Chama, New Mexico August 14; Fort Collins August 9; Denver July 16; Golden June 19; Morrison June 23.

But one specimen, a female, was taken at Montevista, and its wings are pale citron basally. The same is true of four males from Chama, New Mexico, but all the others have the base of the wings hyaline. This appears to be quite constantly the case with specimens from opposite sides of the divide.

60. MESTOBREGMA PLATTEI Thomas.

Œdipoda plattei THOMAS, Rept. U. S. Geol. Surv. Terr., V, 1873, p. 123.

Seven males, seventeen females, Denver July 26; Chimney Gulch July 27; Pine Grove July 23; Golden June 6 and August 21.

The distinguishing feature of this species seems to be the pallid coloring of the inferior posterior part of the lateral lobes of the thorax and the bands of the tegmina extending only across the costal half. The elytral markings resemble those of *Trimerotropis pseudofasciatus.*

61. MESTOBREGMA PULCHELLA Bruner.

Mestobregma pulchellum BRUNER, Proc. U. S. Nat. Mus., XII, 1890, p. 64–65.

One male at Fort Collins August 9. This specimen agrees in every particular with Bruner's type in the U. S. National Museum. This species was omitted from Scudder's catalogue. It is a true *Mestobregma*, and is very closely allied to *M. kiowa* in markings, and may prove to be a synonym of that species. The color is its most distinguishing feature, and that may be due to environment. The food plant from which it was described, *Eurotia lanata*, is recorded as occurring from the "Northwest Territories to western Nebraska, New Mexico, Nevada, and California."

62. METATOR PARDALINUM Saussure.

Œdipoda pardalinum SAUSSURE, Rev. Mag. Zool., XIII, 1861, p. 324.

Nineteen males, twelve females, Fort Collins August 11; Morrison June 29; Golden June 19 and 30.

Nine males and six females having the base of the wings yellow, but in every other particular like the red-winged specimens, were taken at the same localities and on the same dates. Very probably these yellow-winged forms are the *Mestobregma maculosum* of Saussure.

63. PSINIDIA SULCIFRONS var.-AMPLICORNUS, new variety.

(Plate LV, fig. 2.)

Superficially resembling *P. sulcifrons*, but differing from typical specimens in several particulars. Color grayish mottled with fuscous; head as in *sulcifrons;* the antennæ are fuscous and greatly depressed in both sexes, and nearly twice as broad as those of typical *sulcifrons;* pronotum and elytra about as in *sulcifrons*, except that the posterior margin of the pronotum of the female is apparently more sharply angulate. Wings with the black band usually somewhat wider than in *sulcifrons*, leaving slightly less of the tip free, the tip infuscated, more so in the male. Posterior femora slender and more flattened, the dorsal carina much more elevated and thinner than in typical *sulcifrons;* the posterior tibiæ are quite uniformly blue, paling somewhat basally, those of the female much lighter colored than those of the male. The color of the tibiæ may be expected to vary considerably in coloration when a number of specimens are examined. The size is about the same as that of *sulcifrons*, the measurements of the type specimens being as follows:

Length of body, male, 21 mm., female, 28; antennæ, male, 12 mm., female, 13 mm.; elytra, male, 19 mm., female, 24 mm.; posterior femora, male, 13 mm., female 16 mm.

One male, one female, Victoria, Texas, June, 1902.

Type No. 6602, U.S.N.M.

64. CONOZOA WALLULA Scudder.

Psinidia wallula Scudder, Rept. U. S. Ent. Comm., II, app., 1881, pp. 27–28, pl. XVII, figs. 13, 14.

Thirteen males, four females, Grand Junction July 7 and August 17; Montrose August 17.

65. TRIMEROTROPIS BRUNERI McNeill.

Hadrotettix gracilis Scudder, Psyche, IX, 1900, pp. 67–68.
Trimerotropis bruneri McNeill, Psyche, IX, 1900, p. 31.—Scudder, Proc. Davenp. Acad. Nat. Sc., IX, 1902, p. 37.

Two females, Sedalia July 11.

66. TRIMEROTROPIS CITRINA Scudder.

Trimerotropis citrina Scudder, Bull. U. S. Geol. Surv. Terr., II, 1876, p. 265.

This species has been taken at various places in Colorado. One male specimen taken at Golden has the black band on the wing somewhat broader than usual.

67. TRIMEROTROPIS GRACILIS Thomas.

Oedipoda gracilis THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1871, p. 461.
Derotmema lichenosum SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1900, pp. 394–395.

Eight males, four females, Durango August 15.

The color of this insect makes it almost invisible when at rest on the naked ground.

68. TRIMEROTROPIS LATICINCTA Saussure.

Trimerotropis laticincta SAUSSURE, Prodr. Œdip., 1884, pp. 169, 170.

Two males, three females, Fort Collins August 19; one male, two females, Montrose August 13; one male, Grand Junction August 17; two females, Denver July 16; one female, Baileys July 30; two males, Golden August 21.

The males are somewhat variable in size, the measurements of the elytra ranging from 24 to 29 mm. It was quite unexpected to find this species so common and widely distributed. By the table given by McNeill these specimens run very persistently to this species.

69. TRIMEROTROPIS MODESTA Bruner.

Trimerotropis modesta BRUNER, Proc. U. S. Nat. Mus., XII, 1890, p. 72.

Six males, two females, Durango August 13; and Golden July 27.

The type of this species has the elytral bands quite distinct, decidedly more so than the greater number of specimens. At Golden it occurred up in the gulch in the foothill fauna. This is the first record of its occurrence east of the Rocky Mountains.

70. TRIMEROTROPIS MONTICOLA Saussure.

Trimerotropis monticola SAUSSURE, Prodr. Œdip., 1884, p. 170.

Seven males, five females, Cripple Creek July 26; Baileys July 13; Golden June 17 and July 27; Pikes Peak July 21; Denver July 22.

One of the females from Baileys has the black transverse band of the wing scarcely one-sixth as broad as the length of the wing and interrupted along the first anal vein. This specimen is also smaller than usual, the elytra measuring 25 mm. and the posterior femora 12 mm. All the specimens are from the foothill fauna except those from Denver. These Denver specimens, however, agree perfectly with specimens from Pikes Peak and other high altitudes.

71. TRIMEROTROPIS PSEUDOFASCIATA Scudder.

Trimerotropis pseudofasciata SCUDDER, Ann. Rept. Chief Eng., 1876, p. 514.

Eight males, four females, Chimney Gulch July 27; Pine Grove July 23; Salida August 1; Durango August 15.

The posterior tibiae of this species vary in color from yellow to distinctly blue. The type, according to McNeill, should be in the collection of the National Museum but can not now be found.

72. TRIMEROTROPIS SIMILIS Scudder.

Trimerotropis similis SCUDDER, Rept. U. S. Ent. Comm., II, app., 1881, p. 27.

Ten males, three females, Platte Canyon May 23; Pine Grove July 8; Palisades July 8; Salida August 6; Golden July 11; Chimney Gulch July 27; Morrison June 27.

All these specimens were taken in the foothill fauna, and they do not seem to occur on the prairie. There is some variation in the elytral bands, some specimens having them much more contrasted than others.

73. TRIMEROTROPIS VINCULATA Scudder.

Trimerotropis vinculata SCUDDER, Proc. Bost. Soc. Nat. Hist., XVIII, 1876, p. 270.

Twenty males, fifteen females, Platte Canyon May 25 and July 10; Sedalia July 11; Montrose August 17; Montevista August 13; Salida August 6; Palisades July 8; Delta July 9; Fort Collins August 9; Denver June 21; and Grand Junction July 7.

74. CIRCOTETTIX AZURESCENS Bruner.

Trimerotropis azurescens BRUNER, Proc. U. S. Nat. Mus., XII, 1890, pp. 69–70.
Trimerotropis perplexa BRUNER, Proc. U. S. Nat. Mus., XII, 1890, pp. 74–75.

One male, Montrose August 17; one female, Fort Collins August 10.

This is a true circotittix, the radials of the wings being distinctly swollen. The above synonymy is based upon a study of type specimens.

75. CIRCOTETTIX CARLINIANUS Thomas.

Œdipoda carlinianus THOMAS, Proc. Acad. Nat. Sci. Philad., 1870, p. 81.

Six males, eight females, Fort Collins August 10; one male, Morrison June 29.

One of the male specimens has the hyaline portion of the wings extending quite to the base in the anterior and middle fields.

76. CIRCOTETTIX SUFFUSUS Scudder.

Trimerotripis suffusus SCUDDER, Bull. U. S. Geol. Surv. Terr., II, 1876, p. 265.
Trimerotropis columbia SCUDDER, Rept. Ent. Soc. Ont., XXIII, 1893, p. 77.

Three males, one female, Chama, New Mexico August 14.

77. CIRCOTETTIX UNDULATUS Thomas.

Œdipoda undulatus THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1871, p. 460.

Twenty-six males, twenty females, Chimney Gulch June 19; Baileys July 13; Pine Grove July 18 and 27; Golden, in foothills, July 27;

Chama, New Mexico August 14; Rico August 16; Cumbres August 11; Durango August 15; Pikes Peak July 21; Cripple Creek July 26.

This common species is one of the noisiest insects that inhabit the canyons.

78. CIRCOTETTIX VERRUCULATUS Kirby.

Locusta verruculatus Kirby, Faun. Bor. Amer., IV, 1837, p. 250.

Eight males, one female, Pine Grove July 16 and 23; Platte Canyon May 25.

This is even a more noisy species than *C. undulatus*. They fly during the hottest part of the day and the sharp crackling noise made by their wings may be heard for long distances. On quiet days I have distinctly heard them for almost or quite half a mile. Often they will remain suspended almost stationary in the air, making the welkin ring with their shrill crackling.

79. HADROTETTIX TRIFASCIATUS Say.

Gryllus trifasciatus Say, Amer. Ent., III, 1828, p. 78, pl. xxxiv.

One female at Victoria, Texas on July 10, and many specimens of both sexes, both mature and immature, in Colorado at Denver, Golden, and Fort Collins from June 7 to August 10.

This is apparently not a common insect in southern Texas, though farther north it is very common, as indicated by the above records. At Victoria I saw but the one specimen and no nymphs.

80. HELIASTUS GUANIERI, new species.

(Plate LV, fig. 3.)

Of small size, pale testaceous, scarcely paler below. Head prominent, nearly smooth, face almost perpendicular; eyes small, subglobular, about half as long as the infraocular part of the genæ; antennæ long, about four-fifths as long as the posterior femora, fine and filiform in the female, coarser and slightly flattened apically in the male. Pronotum constricted mesially, flaring both in front and behind, anterior margin slightly rounded, mesially subimmarginate, posterior margin obtuse-angularly rounded; median carinæ almost obsolete except on the metanotum where it is present as a fine raised line; lateral carinæ present only posterior of the typical sulcus and there very rounded; descending lobes of the pronotum apically subtruncate, in no wise descending below the free pleural lobes anterior to them. The tegmina extend to or slightly beyond the tips of the hind femora and are quite broad, about one-fifth as broad as long, the tips well rounded and the anterior and posterior margins about equally rounded, uniformly pale testaceous or with more or less maculation, along the posterior margin generally with separate and distinct fuscous spots. Intercalary vein absent. Wings hyaline, veins greenish. Fore and

middle legs more or less distinctly banded with black, posterior femora pale testaceous, paler below and on the inner side, dorsally and on the upper part of the outer face marked by two oblique dark bands, one median and one subapical; hind tibiæ red, paling somewhat on the basal fourth; spines red at the base, the apical half black.

Length of body, male, 14 mm.; female, 19–20 mm.; antennæ, male, 7.5 mm.; female, 8 mm.; elytra, male, 11 mm.; female, 15–16 mm.; hind femora, male, 9 mm.; female, 9.5–10 mm.

Type.—No. 6600, U.S.N.M. Described from specimens from Colorado collected by G. Guanier at Pueblo many years ago. I collected one specimen, a female, at Fort Collins, on August 11, and the U. S. National Museum contains specimens from Douglas County, Kansas, and others labeled "Colorado."

This species is probably the nearest allied to *Heliastus minimus*, but the long antennæ and the red hind tibiæ, together with the habitat, will serve to separate them.

Regarding the posterior tibiæ of *H. minimus*, Professor Morse writes me as follows: "Hind tibiæ of *Heliastus minimus* are luteous—pale yellowish buff—probably almost ivory white in life."

81. BRACHYSTOLA MAGNA Girard.

Brachypeplus magnus GIRARD, Marcy, Expl. Red River, 1853, p. 260, pl. XV, figs. 1–4.

Several specimens, mature and immature, at Golden, on poppy plants in July. *Brachypeplus virescens* Charpenter is very probably a synonym of this species. If such should prove the case, the name *virescens* would have preference, being established several years previous to *magna*.

Subfamily ACRIDIINÆ.

82. TÆNIOPODA PECTICORNIS Walker.

Rhomalea pecticornis WALKER, Cat. Derm. Salt., III, 1870, p. 538.

Tæniopoda picticornis STÅL, Rec. Orth., I, 1873, p. 51.—THOMAS, Rept. U. S. Geol. Surv. west 100 merid., V, 1875, p. 898.—SCUDDER and COCKERELL, Proc. Davenp. Acad. Sci., IX, 1902, p. 39.

Specimens of this fine insect were sent to the Division of Entomology by Mr. E. Meyenberg, of Pecos, Texas, with the statement that they were taken at the base of the foothills of the Guadalupe Mountains. This species does not appear in Scudder's catalogue.

83. DICTYOPHORUS RETICULATUS Thunberg.

Dictyophorus reticulatus THUNBERG, Mem. Acad. St. Petersb., V, 1815, p. 259.

This handsome insect is quite common in some cotton fields about Victoria, Texas, where it matures about the end of June. The con-

spicuously marked nymphs are no less striking in appearance than the mature individuals, in fact being easier seen at a distance than the imagoes.

An apparently unrecorded fact regarding this species was noted in the field. Both sexes, but especially the males, when disturbed make a distinct simmering or bubbling sound, high-noted, but of small volume. Upon investigation, this sound was found to proceed from a gland, probably a modified spiracle, opening from the side of the body above and slightly behind the middle coxæ. The sound is produced by the insects forcing out very minute bubbles of a clear liquid, causing a sound sufficiently loud to be heard for some distance. Whether this liquid has repelling properties and the resulting sound purely mechanical, or whether the production of sound is the main object of the mechanism, was not determined.

84. SCHISTOCERCA ALUTACEA Harris.

Acridium alutacea Harris, Ins. Inj. Veg., 1841, p. 139.

One female specimen at Grand Junction August 17, and one male by Oslar, labeled "Colorado."

85. SCHISTOCERCA AMERICANA Drury.

Gryllus americana Drury, Ill. Nat. Hist., I, 1770, p. 128, pl. xlix, fig. 2.

This species is quite common at times in the cotton fields of Texas. Several specimens were taken at Victoria in June and July.

86. SCHISTOCERCA OBSCURA Fabricius.

Gryllus obscura Fabricius, Suppl. Ent. Syst., 1798, p. 194.

One large female from Quero, Texas July 11.

87. SCHISTOCERCA SHOSHONE Thomas.

Acridium shoshone Thomas, Proc. Acad. Nat. Sci. Philad., 1873, p. 165.

Two large females from Yuma, Arizona, and one male from Phoenix, Arizona. Immersion in alcohol seems to discolor these insects to a considerable extent, changing the green to light brown and the color of hind tibiæ from red to yellow.

88. PARAIDEMONA MIMICA Scudder.

Paraidemona mimica Scudder, Proc. U. S. Nat. Mus., XX, 1897, pp. 42, 43–44, pl. iii, fig. 10.

Many specimens of both sexes in cotton fields in the vicinity of Victoria, Texas, in June and July. This seems to be the common species in that section of the State, no other species being represented among the many specimens examined. It is quite variable, both in size and coloration.

89. HYPOCHLORA ALBA Dodge.

Pezotettix alba Dodge, Can. Ent., VIII, 1876, p. 10.

Two males and three females at Fort Collins August 9, and one female at Boulder on August 13.

90. HESPEROTETTIX PRATENSIS Scudder.

Hesperotettix pratensis Scudder, Proc. U. S. Nat. Mus., XX, 1897, pp. 57, 64–66, pl. v, fig. 3.

Four males, two females, Pine Grove July 18, and Grand Junction July 7.

91. HESPEROTETTIX SPECIOSUS Scudder.

Pezotettix speciosus Scudder, Rept. U. S. Geol. Surv. Nebr., 1871, p. 250.

Found quite common in long grass in southern Texas in June and July. It apparently matures in that section about the end of June. A number of specimens were taken in cotton fields.

92. HESPEROTETTIX VIRIDIS Thomas.

Caloptenus viridis Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V., 1872, p. 450, pl. II, fig. 3.

Ten males, nineteen females, Pikes Peak July 21; Golden June 19 to August 21; Fort Collins August 11; Denver July 16.

Males of this species are quite variable in size.

92. ÆOLOPLUS CHENOPODII Bruner.

Pezotettix chenopodii Bruner, Ins. Life, VII, 1894, pp. 41–42.

Numerous specimens of this interesting species were taken at Palisade July 8 in a patch of low prickly shrubs just across the railroad from the station, which I suppose is the Chenipodaceous plant on which the species was originally recorded as feeding. Specimens were also taken at Grand Junction and Delta. They were seen mating at the latter place on August 17, and on the latter date some apparently full grown nymphs were taken. These nymphs were uniformly light yellowish in color and the thorax more tectiform than in mature individuals. Among the mature specimens taken were some individuals almost unicolorous, without fuscous markings.

94. ÆOLOPLUS PLAGOSUS Scudder.

Pezotettix plagosus Scudder, Ann. Rept. Chief Eng., 1876, p. 504.

Numerous specimens from the side of Tenderfoot Mountain, just across the railroad from the station at Salida from August 1 to 7. They were very common and frequently found mating. One female specimen was also taken at Sedalia and the color of that specimen is of

a decidedly yellowish cast, radically different from the dark-brown color that characterized all the Salida specimens except one which was colored similar to the Sedalia specimen.

95. ÆOLOPLUS REGALIS Dodge.

Caloptenus regalis Dodge, Can. Ent., VIII, 1876, pp. 11, 12.

Four males, four females, Fort Collins August 10.

Some specimens have the elytra greenish, but generally they are brownish. One pair was taken mated.

96. ÆOLOPLUS TURNBULLI Thomas.

Caloptenus turnbulli Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V., 1872, p. 452, pl. II, fig. 10.

One male, one female, Delta July 13.

These specimens are unusually brachypterous, the elytra covering but little more than half of the abdomen. The female is also smaller than usual, but otherwise both specimens are typical. The posterior tibiæ are variable in color, those of the female greenish yellow with a pallid subbasal annulus, while those of the male are testaceous merging into pale reddish on the basal third. The measurements of these two specimens are as follows:

Length of body, male and female, 16 mm.; antennæ, male, 5 mm.; female, 4 mm.; pronotum, male and female, 3.5 mm.; elytra, male and female, 7 mm.; posterior femora, male, 7.5 mm.; female, 8 mm.

97. MELANOPLUS ALTITUDINUM Scudder.

Pezotettix altitudinum Scudder, Proc. Bost. Soc. Nat. Hist., XX, 1879, p. 86.
Melanoplus huroni Blatchley, Psyche, VIII, 1898, pp. 195, 196.

Seven males, eight females, Pine Grove July 18, at the head of a side gulch nearly a thousand feet above the town. Also one pair from Pikes Peak July 21, one female above Boulder June 9, and one male above Golden June 17.

The elytra of these specimens are somewhat variable in length, in the male sex varying from 4.75 to 6 mm. There are several specimens of this species in the United States National Museum named by Dr. Scudder, and the male tegmina vary from 5.5 to 9.5 mm. and the female tegmina vary from 7.5 to 11 mm. in length. But these higher measurements seem exceptional, the usual length of elytra being about 6 mm. in the males and 7 mm. in the females. Types of *Melanoplus huroni* Blatchley are in the National Museum and seem to be identical with specimens of *altitudinum* from various localities in the West. It is not clear why Dr. Scudder placed this species in the *Borckii* series of the genus, as it surely does not belong there.

98. MELANOPLUS ATLANIS Riley.

Caloptenus atlanis RILEY, Ann. Rept. Ins. Mo., VII, 1875, p. 169.

This species was taken at various points in Colorado on both sides of the divide. Specimens were also taken on the summit of Pikes Peak on snow fields on July 20. The color of the posterior tibiæ vary from bright red to yellow and blue.

99. MELANOPLUS BIVITTATUS Say.

Gryllus bivittatus SAY, Journ. Acad. Nat. Sci. Philad., IV, 1825, p. 308.

Six males, twelve females, Denver July 16; Golden June 19 and August 21; Fort Collins August 10.

A pair from Fort Collins is brachypterous, the wings covering but little more than half of the abdomen. The male is quite small, measuring as follows:

Length, 22 mm.; elytra, 9 mm.; hind femora, 12 mm.

100. MELANOPLUS BOWDITCHI Scudder.

Melanoplus bowditchi SCUDDER, Proc. Bost. Soc. Nat. Hist., XX, 1879, p. 72.

Two males, six females, Fort Collins August 9; Salida August 6; also one male from Williams, Arizona. The Colorado specimens have the male furcula shaped considerably like those of *M. pictus* as illustrated on Plate XI of Scudder's Revision of the Melanopli. The specimen from Arizona has these organs more rounded out on the inner side than usual. Some specimens from Salida are in the collection of the Colorado Agricultural College labeled "bowditchi or n. sp."

101. MELANOPLUS COCCINEIPES Scudder.

Melanoplus coccineipes SCUDDER, Proc. Amer. Phil. Soc., XXXVI, 1897, pp. 26, 34.

Thirteen males and eleven females from Golden, Denver, and Fort Collins from July 11 to August 23.

102. MELANOPLUS COLLINUS Scudder.

Melanoplus collinus SCUDDER, Proc. Bost. Soc. Nat. Hist., XIX, 1878, p. 285.

One male specimen taken at Fort Collins August 10. This specimen is indistinguishable from specimens from Virginia and Canada. It has not, I believe, been recorded from Colorado before.

103. MELANOPLUS COLORADUS, new species.

(Plate LV, Figs. 1, 1*a*.)

One male specimen from Palisade July 8.

Of medium size, testaceous, very closely related to *M. propinquus* in general appearance. Head quite prominent, flavo-testaceous, darker

above with a scarcely discernible trace of a postocular band, though with more specimens there would probably be some variation in this respect. The vertex is tumid and slightly elevated above the thorax; interspace between the eyes about as broad as the basal segment of the antennæ; frontal costa subequal, flat, biseriately punctate above the ocellus, below shallowly sulcate, just failing to reach the clypeus; eyes moderately prominent, a little longer than the infracular part of the genæ; antennæ flavo-testaceous, about three-fourths as long as the posterior femora. Pronotum very slightly enlarging from in front backward, the carinæ as in *M. propinquus;* color testaceous with a black postocular band on the prozona, not extending onto the metazona; front margin truncate, scarcely at all flaring, hind margin obtusangulate. Prosternal spine and mesosternal foramine as in *propinquus.* Tegmina considerably passing the posterior femora, very slender in form and uniformly testaceous, immaculate. Fore and middle femora considerably swollen, hind femora very pale testaceous above, paler below, without bands, but with black genicular arcs. Posterior tibiæ uniformly red, spines wholly black, eleven in number in the outer series. Extremity of abdomen quite noticeably clavate, moderately recurved, the supraanal plate strongly depressed apically, almost hidden by the more than usual developed pallium, lateral margins moderately elevated, median sulcus moderately deep with narrow, elevated margins; furcula two-thirds as long as the supraanal plate, broad and touching at the base for a third of their length and quite thin, narrowing abruptly to half their basal width and continuing as cylindrical oval terminating fingers, slightly curving inward; cerci relatively broader than those of *propinquus*, tapering more on the upper side than on the lower and obliquely truncate apically, the upper edge of the apex bluntly acute; subgenital plate as in *propinquus.*

Length of body from head to tip of the abdomen, 21 mm., antennæ, 8 mm., elytra, 18 mm., hind femora, 12 mm.

Type.—No. 6599, U.S.N.M.

The broader cerci, pallid lower surface of the posterior femora, and the habitat will serve to separate this species from its nearest ally, *M. propinquus.* It belongs to the femur rubrum series.

104. MELANOPLUS DIFFERENTIALIS Thomas.

Acridium differentialis THOMAS, Trans. Ill. St. Agric. Soc., V, 1865, p. 450.

Many specimens at Victoria, Texas in June and July and on both sides of the divide in Colorado. At Grand Junction I took a number of fine large specimens of both sexes on August 17 that were uniformly brownish in color and very large. In Texas they were very numerous along roadsides in rank weeds, flying up in swarms at the approach of the buggy. In the streets of Denver black individuals were taken on several occasions.

105. MELANOPLUS FASCIATUS Walker.

Caloptenus faciatus WALKER, Cat. Derm. Salt., IV, 1870, p. 680.

Two males at Pine Grove on July 18.

106. MELANOPLUS FEMUR-RUBRUM De Geer.

Acridium femur-rubrum DE GEER, Mem., III, 1773, p. 498, pl. XLII, fig 5.

Two males, twenty-seven females, Montevista August 13; Golden August 23; Fort Collins August 10; Denver July 16; Montrose August 13; Glenwood Springs August 18; Grand Junction August 17; Palisade July 8; Mancos August 16.

107. MELANOPLUS FLABELLATUS Scudder.

Melanoplus flabellatus SCUDDER, Proc. Bost. Soc. Nat. Hist., XX, 1879, pp. 82–83.

This species was found mating in considerable numbers in the edge of an open piece of woods near Victoria, Texas on June 28.

108. MELANOPLUS FLAVIDUS Scudder.

Melanoplus flavidus SCUDDER, Proc. Bost. Soc. Nat. Hist., XX, 1879, p. 74.

Nine males, thirteen females, Golden June 19 and August 21; Fort Collins August 11.

Some of these specimens are quite brightly yellowish and others are quite uniformly brown, except the posterior tibiae. Some specimens have the lateral lobes of the pronotum with a black postocular band and some are unicolorous. All have the hind femora bifasciate with fuscous above.

109. MELANOPLUS GLADSTONI Scudder.

Melanoplus gladstoni SCUDDER, Proc. Amer. Phil. Soc., XXXVI, 1897, pp. 23, 33.

Eleven males, ten females, Golden August 21; Fort Collins August 9.

The specimens from Colorado and Nebraska mentioned by Scudder on page 230 of his revision of the Melanopli agree exactly with this lot from Colorado, otherwise these would have been treated of here as *conspersus*, for *gladstoni* and that species must be very similar, in fact, Colorado specimens in the collection of the Colorado Agricultural College are labeled as *conspersus*. The cerci of some of the specimens, both of the present lot from Colorado and those mentioned above from Nebraska, are apically bent inward at almost a right angle. It may be that they are the true *conspersus*, and *gladstoni* occurs only further north. Or, still more likely, *gladstoni* and *conspersus* are forms of one variable species. To settle this the type of *conspersus*, or typical examples, must be seen.

110. MELANOPLUS INFANTILIS Scudder.

Melanoplus infantilis Scudder, Proc. Bost. Soc. Nat. Hist., XX, 1879, pp. 65–67.

Ten males, eight females, Baileys July 13; Cripple Creek July 26; Fort Collins August 10; Morrison June 27; Denver July 16.

111. MELANOPLUS INTERMEDIUS Scudder.

Melanoplus intermedius Scudder, Proc. Amer. Phil. Soc., XXXVI, 1897, pp. 20, 32.

Twenty males, nineteen females, Montrose August 17; Glenwood Springs August 18.

112. MELANOPLUS LAKINUS Scudder.

Pezotettix lakinus Scudder, Proc. Bost. Soc. Nat. Hist., XX, 1879, pp. 79–80.

Six males, four females, Fort Collins, August 9. One pair mating.

113. MELANOPLUS LATIFERCULA, new species.

(Plate LV, fig. 4, 4*a*.)

One male from Cumbres, Colorado, August 14.

A brachypterous species of small size and very dark fuscous in color: head moderately prominent, dark fuscous above and on the upper portion of the genæ, elsewhere dark ashen except for a broad piceous postocular band; vertex elevated considerably above the pronotum, somewhat tumid; interspace between the eyes noticeably broader than the basal segment of the antennæ; frontal costa but slightly broader than the space between the eyes, with the margins parallel and punctate throughout, very shallowly sulcate at and below the ocellus, just failing to reach the clypeus; eyes neither large nor prominent, a little longer than the infraocular part of the genæ. Antennæ fuscous, two-thirds as long as the posterior femora. Pronotum subequal, very slightly enlarging posteriorly, uniformly dark fuscous except for a broad, slightly broken, postocular stripe which does not extend on to the metanotum; the disk passes into the perpendicular lateral lobes with an abrupt turn, making the lateral carinæ well marked; front border truncate, in no wise flaring to receive the head; posterior border very obtusely angled, the angle rounded; prosternal spine short, erect, subquadrate, and bluntly rounded at the apex; interspace between the mesosternal lobes quadrate, metasternal lobes approximate. Tegmina abbreviate, but little longer than the pronotum, overlapping and apically pointed, immaculately fuscous; fore and middle femora quite strongly tumid, the anterior ones the more so; hind femora quite stout, dark fuscous except below where they are dark red, with darker geniculations preceded by a pallid band; spines black to the base, ten in number in the outer series. Tip of the abdomen scarcely clavate, considerably upturned, the supraanal plate apically

concealed by the ample pallium and with the sides partially hidden beneath the short broad infracercal plates which overlie the borders of the supraanal plate in this species; the median sulcus narrow with moderately elevated margins; furcula well developed, half as long as the supraanal plate and very broad, nearly half as broad as long, touching at the base and narrowed distally to a broadly rounded apex, the narrowing more on the inner side; cerci very broad, about twice as long as the basal width, tapering but little and that on the under side of the apical third, the tip broadly rounded, the whole gently upcurved but scarcely inclined inwards; subgenital plate black, the tip elevated a little above the lateral margins and narrowly and shallowly but distinctly notched.

Length of body, 16 mm.; antennæ, 6.5 mm.; pronotum, 4 mm.; elytra, 5 mm.; hind femora, 9.5 mm.

Type.—No. 6601 U.S.N.M.

This species appears to belong to the mancus series.

114. MELANOPLUS MINOR Scudder.

Caloptenus minor SCUDDER, Proc. Bost. Soc. Nat. Hist., XVII, 1875, p. 478.

Sixteen males, sixteen females, Glenwood Springs July 5; Sedalia June 15 and 21; Denver July 16.

115. MELANOPLUS OCCIDENTALIS Thomas.

Caloptenus occidentalis THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 453, pl. II, fig. 2.

Seventy-four males, forty-nine females, Cripple Creek July 26; Morrison June 29; Golden June 19 and July 11; Boulder June 9; Durango June 12; Denver July 16; Pikes Peak July 21; Fort Collins August 10; Baileys July 30; Sedalia June 21; Glenwood Springs July 5.

Though the type of both this species and *M. cuneatus* are in the Museum collection I can find no stable character for separating them. The latter is the larger species, considering only the types, but with a series, such as the one now before me, that is seen to be inadequate for their separation. As for the tubercled subgenital plate of *occidentalis*, as given by Scudder for the separation of that species from *cuneatus*, I must confess an inability to make anything out of it. The cerci of *cuneatus* seem however to be shorter and inferiorly more lobed than in *occidentalis*.

The males of this species, as represented by this series, vary in measurements as follows:

Length of body, 19 to 23 mm.; elytra, 8.5 to 16 mm.; hind femora, 10 to 11 mm. The specimen from which the minimum measurement of the elytra was taken was collected at Glenwood Springs on July 5, and is an unique specimen of its kind so far as recorded, no other known individual having elytra less than 12 mm. in length.

116. MELANOPLUS PACKARDII Scudder.

Melanoplus packardii Scudder, Proc. Bost. Soc. Nat. Hist., XIX, 1878, p. 287.

One female specimen in cotton field at Victoria, Texas, in late June; apparently not very common. In Colorado specimens of both sexes were taken at the following places: Denver July 16; Golden August 21 and Morrison June 28.

117. MELANOPLUS PLUMBEUS Dodge

Caloptenus plumbeus Dodge, Can. Ent., IX, 1877, p. 12.

Seventeen males, nine females, Denver July 16.

The elytra of some specimens are almost fuscous and distinctly maculate, and the general color varies from fuscous to flavous. But the flavous stripe on a darker background is constant, and specimens of this species can be separated from *femur-rubrum* with considerable certainty by that character and the general appearance. But those two species are very close and may prove to be forms of the same thing.

118. PHOETALIOTES NEBRASCENSIS Thomas.

Pezotettix nebrascensis Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 455.

Seven males, six females, Fort Collins August 10. One pair is macropterous, but all the rest are brachypterous.

119. PAROXYA FLORIDANA Thomas.

Caloptenus floridana Thomas, Bull. U. S. Geol. Surv. Terr., 1, 1874, pp. 2, 68.

Two females, Victoria, Texas, in June, 1902. These specimens are typical in having the fuscous stripe of the lateral lobes of the pronotum abruptly terminated at the posterior sulcus. Specimens of this species taken in numbers at Rosslyn, Virginia, usually have this stripe percurrent, though behind the posterior sulcus it is not generally so well defined.

120. DACTYLOTUM PICTUM Thomas.

Pezotettix pictum Thomas, Proc. Acad. Nat. Sci. Philad., 1870, p. 78.

A few specimens of both sexes, also nymphs, at Denver, July 26; Golden, July 27; and Fort Collins, August 10.

Family LOCUSTIDÆ.

121. ARETHÆA PHALANGIUM Scudder.

Ægipan phalangium Scudder, Proc. Bost. Soc. Nat. Hist., XIX, 1877, p. 40.

Three females were taken in the vicinity of Victoria, Texas, in the latter part of June, 1902. They were all flying in open prairies, and other specimens were seen but not taken. They do not usually take long flights, generally no more than 50 or 100 yards. There is some variation in the radial branches of the elytra, the *multiramosa* of Brunner representing such variation.

122. SCUDDERIA CURVICAUDA De Geer.

Locusta curvicauda De Geer, Mem., III, 1773, p. 446, pl. xxxviii, fig. 5.

One pair at Victoria, Texas, in June.

123. SCUDDERIA FURCATA Brunner.

Scudderia furcata Brunner, Monogr. Phaner., 1878, p. 239, pl. v, fig. 72a.

One mature female by E. J. Oslar, marked "Colorado," and one immature specimen which probably belongs to this species was taken at Golden on July 18.

124. SCUDDERIA TEXENSIS Saussure and Pictet.

Scudderia texensis Saussure and Pictet, Biol. Cent.-Amer., Orth., 1897, I, pp. 328, 329, 330, pl. xv, figs. 18, 19.

One female at Victoria in June, 1902.

125. AMBLYCORYPHA HUASTECA Saussure.

Phylloptera huasteca Saussure, Rev. Mag. Zool., XI, 1859, p. 205.

Quite common in lowlands in southern Texas. A number of specimens were taken near Victoria, and in early July I saw hundreds of them taking short flights over a piece of low prairie.

126. AMBLYCORYPHA UHLERI Stål.

Amblycorypha uhleri Stål, Bih. Sv. Vet.-akad. handl., IV, 1876, No. 5, p. 57.

Several specimens at Victoria in June.

127. MICROCENTRUM LAURIFOLIUM Linnæus.

Gryllus (*Tettigonia*) *laurifolium* Linnæus, Syst. Nat., 10th ed., I, 1758, p. 429.

One male at Durango, by E. J. Oslar.

128. CONOCEPHALUS ENSIGER Harris.

Conocephalus ensiger Harris, Ins. Inj. Veg., 1841, p. 131.

Three males and two females, by E. J. Oslar, marked "Colorado." One of the specimens, a male, is brown, all the others green.

129. CONOCEPHALUS TRIOPS Linnæus.

Gryllus (*Tettigonia*) *triops* Linnæus, Syst. Nat., 10th ed., I, 1758, p. 430.

At Victoria, Texas, a mature male and an apparently half-grown nymph were taken on July 10 in grass near an old irrigating reservoir.

130. ORCHELIMUM HERBACEUM Serville.

Orchelimum herbaceum Serville, Orth., 1839, p. 524.

Specimens of this species were taken in Texas, where it is not as common as the next species, with which it was found associated. Specimens were also taken in Colorado, by E. J. Oslar, but are without locality or date.

131. ORCHELIMUM LONGIPENNE Scudder.

Orchelimum longipenne SCUDDER, Bost. Journ. Nat. Hist., VII, 1862, p. 453.

Quite common in the vicinity of lakes or water courses in southern Texas. The species differ from *herbaceum* in having a slightly longer ovipositor, and the form is not nearly so slender, especially in the males. The presence or absence of a dorsal stripe on the pronotum is not a very stable character for the separation of species in this genus, as there is considerable variation in this respect.

132. XIPHIDIUM FASCIATUM De Geer.

Xiphidium fasciatum DE GEER, Mem., III, 1773, p. 458, pl. XL, fig. 4.

A common and widely spread species. It often comes to light, sometimes in considerable numbers. Many specimens of both sexes were taken at Victoria, Texas, in June and July, and one male specimen was taken at Montevista, Colorado, on August 13.

133. XIPHIDIUM SALTANS Scudder.

Xiphidium saltans SCUDDER, Rept. U. S. Geol. Surv. Nebr., 1871, p. 249.

One male and six females at Fort Collins, August 10, in rank grass.

134. XIPHIDIUM STRICTUM Scudder.

Xiphidium strictum SCUDDER, Proc. Bost. Soc. Nat. Hist., XVII, 1875, p. 460.

Several females were taken near Victoria, Texas in June, 1902. They were in reeds near a swamp and both mature and immature specimens were taken. No males were seen.

135. XIPHIDIUM VICINUM Morse.

Xiphidium vicinum MORSE, Can. Ent., XXXIII, 1901, p. 203.

Three males and two females of this species were taken at Fort Collins on August 10, in rank grass. The females and one of the males are of the form called *productum* by Professor Morse.

136. CAPNOBATES FULIGINOSUS Thomas.

Locusta fuliginosus THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 443, pl. I, fig. 9.

Two males at Bright Angel, Arizona on July 13, in the Colorado Canyon at an altitude of 3,000 feet. The spines on the outer inferior side of the fore femora of some specimens of this species are wholly wanting, their location being indicated by piceous spots.

137. ANABRUS COLORADUS Thomas.

Anabrus coloradus THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 440.

Six males, five females, Cumbres, August 14; Pikes Peak, July 21, and South Park, by Oslar.

At Cumbres the males were stridulating about 10 o'clock in the morning, and that led to their capture. They were in the grass and would never have been discovered but for their song. But even when once discovered their capture was not at all assured, for they blended in color with the grass so perfectly and were so active in eluding the grasp that many would escape when almost in the bottle.

138. ANABRUS PURPURASCENS Uhler.

Anabrus purpurascens Uhler, Proc. Ent. Soc. Philad., II, 1864, p. 550.

One pair, Fort Collins, August 10, on the prairie out half a mile from the foothills. The males were stridulating.

139. EREMOPEDES BALLI Caudell.

Eremopedes balli Caudell, Can. Ent., XXXIV, 1902, p. 100.

Six males, three females, Fort Collins, August 19; five males and three females, Williams, Arizona, from June 6 to July 30, and one male at Flagstaff, Arizona, on July 4. The specimens from Williams were found under bark, quite a surprising fact considering the habitat of the type specimens. In the more immature specimens the lateral lobes are persistently striped with a longitudinal blackish stripe which extends across the thorax and nearly to the end of the abdomen. On the thorax the stripe is sharply defined above and fades out gradually below. At Williams they appear to mature about a month earlier than at Fort Collins, the mature specimens being taken at the former place on July 1. The mature individuals from Arizona have the posterior femora marked externally by two black stripes, as mentioned under the next species.

140. EREMOPEDES UNICOLOR Scudder.

Eremopedes unicolor Scudder, Proc. Davenp. Acad. Nat. Sci., VIII, 1899, p. 97.

One female from Hot Springs, Arizona June 12. This specimen is somewhat larger than the type and the pronotum is somewhat infuscated, the infuscation confined to a little more than the anterior half and not reaching to the inferior margins of the lateral lobes, though there is a dash of black next the margin just above the sinus. The posterior femora have two longitudinal black streaks, converging somewhat posteriorally. The measurements are as follows:

Length of thorax, 8.5 mm.; fore femora, 9 mm.; hind femora, 26 mm.; ovipositor, 19 mm.

141. PLAGIOSTIRA ALBONOTATA Scudder.

Plagiostira albonotata Scudder, Ann. Rept. Chief Eng., 1876, p. 501.

One pair of this handsome insect was taken at Williams, Arizona, on July 24. They were found on sagebrush.

142. ATELOPLUS NOTATUS Scudder.

Ateloplus notatus Scudder, Proc. Davenp. Acad. Nat. Sci., VIII, 1899, p. 98.

One mature female and three nymphs at Hot Springs, Arizona July 13 to 22. The smallest nymphs were collected on the earlier date. The mature specimen agrees with the type specimen in the collection of the National Museum except that there is no dorsal stripe present.

143. CEUTHOPHILUS DEVIUS Scudder.

Ceuthophilus devius Scudder, Proc. Amer. Acad. Arts Sci., XXX, 1894, pp. 30, 99–100.

A mature individual was taken at Durango by Oslar.

144. CEUTHOPHILUS VALGUS Scudder.

Ceuthophilus valgus Scudder, Proc. Amer. Acad. Arts Sci., XXX, 1894, pp. 27, 74–75.

Several specimens of both sexes in South Park, by Oslar.

145. CEUTHOPHILUS VINCULATUS Scudder.

Ceuthophilus vinculatus Scudder, Proc. Amer. Acad. Arts Sci., XXX, 1894, pp. 29, 91–92.

Specimens of what I take to be the young of this species were taken at the head of Chimney Gulch, above Golden, May 13. They were found in an old decaying stump.

146. UDEOPSYLLA ROBUSTA Haldeman.

Phalangopsis robusta Haldeman, Proc. Amer. Assoc. Adv. Sci., II, 1850, p. 346.

One female by E. J. Oslar, marked "Colorado."

Family GRYLLIDÆ.

147. MYRMECOPHILA NEBRASCENSIS Scudder.

Myrmecophila nebrascensis Scudder, Psyche, VIII, 1899, pp. 425, 427–428.

Several specimens of this species were taken at Williams, Arizona, on May 26 and June 3.

148. CYCLOPTILUS SQUAMOSUS Scudder.

Cycloptilus squamosus Scudder, Proc. Bost. Soc. Nat. Hist., XII, 1868, p. 142.

One female specimen on cotton at Victoria, Texas in late June.

149. NEMOBIUS FASCIATUS De Geer.

Gryllus fasciatus De Geer, Mem., III, 1773, p. 522, pl. XLIII, fig. 5.

The macropterous form of this species occurred in large numbers at light in Victoria, Texas during the latter part of June, many hundreds being easily gathered in one evening from the various lights

scattered around through the town. But few brachypterous forms were seen at light. In Colorado but a single specimen of the macropterous form was seen, one by Oslar without date or locality. Brachypterous specimens of both sexes were taken at Fort Collins on August 10.

150. NEMOBIUS UTAHENSIS Scudder.

Nemobius utahensis SCUDDER, Journ. N. Y. Ent. Soc., IV, 1896, pp. 99, 103–104.

One male of what is evidently this species was taken at Sedalia June 15, and a freshly matured one at Montevista August 13.

151. GRYLLUS ABBREVIATUS Serville.

Gryllus abbreviatus SERVILLE, Orth., 1839, p. 336.

One male referable to this species was taken at Fort Collins August 11, and one at Sedalia June 15. The one from Fort Collins was freshly matured when found. An immature female was also taken at Fort Collins August 10.

152. GRYLLUS PENNSYLVANICUS Burmeister.

Gryllus pennsylvanicus BURMEISTER, Handb. Ent., II, 1838, p. 734.

The nymphs of what is evidently this species occurred in the cotton fields about Victoria, Texas in late June. Mature macropterous females were taken in woods under logs in early July. Brachypterous males and females were collected in Colorado at Golden, June 5; Denver, June 17; Platte Canyon, June 10, and Grand Junction, July 7. Mr. Oslar took a macropterous female at Canyon City. A pair of *Gryllus neglectus*, which may be considered a variety of this species, was taken at Canyon City in July by Oslar.

153. GRYLLUS PERSONATUS Uhler.

Gryllus personatus UHLER, Proc. Ent. Soc. Philad., II, 1864, p. 547.

Two males, three females, Grand Junction, by Oslar, all macropterous; one brachypterous male was taken at Winslow, Arizona, by Messrs. Schwarz and Barber.

154. ŒCANTHUS QUADRIPUNCTATUS Beutenmüller.

Œcanthus quadripunctatus BEUTENMÜLLER, Bull. Amer. Mus. Nat. Hist., VI, 1894, pp. 250–251, 271, fig. 5.

This species is quite common in the cotton fields of southern Texas. Specimens were also collected in Colorado at Fort Collins.

EXPLANATION OF PLATE LV.

Fig. 1. *Melanoplus coloradus*, new species, male.
1a. *Melanoplus coloradus*, new species, male, end of abdomen.
2. *Psinidia sulcifrons* var.–*amplicornus*, new variety, female.
3. *Heliastus guanieri*, new species, female.
4. *Melanoplus latifercula*, new species, male.
4a. *Melanoplus latifercula*, new species, male, end of abdomen.

1

1c

4c

2

3

4

SOME AMERICAN ORTHOPTERA.

FOR EXPLANATION OF PLATE SEE PAGE 809.

A REVIEW OF THE CYPRINOID FISHES OF JAPAN.

By David Starr Jordan and Henry W. Fowler,
Of the Leland Stanford Junior University.

In the present paper is given an account of the Cyprinidæ, or carp-like fishes, known to inhabit the rivers and lakes of Japan. In Japan, as in most other regions outside of Polynesia, Australia, and South America, the Cyprinidæ far outnumber all other fresh-water fishes, and probably numerous species yet remain undescribed, especially in the rivers of Kiusiu. This paper is based on material belonging to the United States National Museum and to the museum of Leland Stanford Junior University. Most of it was collected in 1900 by Professors Jordan and Snyder. The illustrative plates are drawn by Mrs. Chloe Lesley Starks and Mr. Charles Bradley Hudson.

Family CYPRINIDÆ.

CARPS.

Margin of the upper jaw formed by the premaxillaries alone; lower pharyngeal bones well developed, falciform, nearly parallel with the gill arches, each provided with 1 to 3 series of teeth in small number, 4 to 7 in the main row, and a less number in the others, if more are present. Head naked; body usually scaly. Barbels 2 or 4, often absent. Belly usually rounded, rarely compressed, never serrated. Gill openings moderate, the membranes broadly joined to the isthmus. Branchiostegals always 3. Gills 4, a slit behind the fourth. Pseudobranchiæ usually present. No adipose fin. Dorsal fin short or elongate. Ventral fins abdominal. Air bladder usually large, commonly divided into an anterior and a posterior lobe, not inclosed in a bony capsule, rarely wanting. Stomach without appendages, appearing as a simple enlargement of the intestines. Fishes mostly of moderate or small size, inhabiting the fresh waters of the Old World and of North America, excessively abundant where found, both in individuals and species. The spring, or breeding dress, of the males is often peculiar. The top of the head, and often the fins or various portions of the body, are covered with small tubercles, outgrowths from the epidermis-

The fins and lower parts of the body in the spring males are often charged with bright pigment, the prevailing color of which is red, although in some genera it is satin-white, yellowish, or black.

a Dorsal fin short, of 8 to 15 rays, usually without serrated spine; no anal spine; air bladder normally placed.

b RHODEINÆ. Intestinal canal elongate, usually more than twice length of body; teeth one-rowed, with grinding surface; lips thin; body compressed; peritoneum black; species herbivorous.

c Barbels none; body deep, compressed; scales rather small, closely imbricated, about 55 in lateral line; teeth 5—5, with serrate edges; anal fin rather long .... *Pseudoperilampus*, 1.

cc Barbels present, at the end of each maxillary; scales large, 36 to 40.

d Body rather deep, rhomboid, compressed.

e Teeth serrate; dorsal long, of about 15 rays........ *Paracheilognathus*, 2.

ee Teeth with entire edges; dorsal moderate, of about 12 rays. *Acheilognathus*, 3.

dd Body rather elongate, lanceolate in outline; dorsal short, of about 10 rays; teeth entire........ *Gnathopogon*, 4.

bb Intestinal canal short, less than twice length of body; teeth one, two, or three rowed; peritoneum usually pale. Species more or less carnivorous.

f Teeth hooked, slender, none of them molar, the grinding surface, if present, very narrow.

g Barbels present, well developed, one of them terminal on the maxillary.

h BARBINÆ. Dorsal fin with its first developed ray thickened or spine-like.

i Barbels two on each side; teeth three-rowed; lips thick; head with mucous cavities........ *Hemibarbus*, 5.

hh GOBIONINÆ. Dorsal fin without spine-like ray; scales large.

j Teeth 1, 2 or 3, 5—6 or 5, 3, 2 or 1, two-rowed.

k Lips thin; mouth, terminal, oblique; dorsal nearly over ventrals........ *Leucogobio*, 6.

kk Lips broad and papillose; mouth small, protracted downward........ *Pseudogobio*, 7.

jj Teeth one-rowed, 5—5.

l Mouth inferior; lips rather thick, ventrals behind front of dorsal.

m Dorsal fin low, its median rays not produced; head rounded above........ *Sarcocheilichthys*, 8.

mm Dorsal fin high, its median rays produced in males; head flattened above........ *Abbottina*, 9.

ll Mouth terminal, oblique, the lower jaw projecting; head depressed and pointed........ *Zezera*, 10.

gg LEUCISCINÆ. Barbels wanting.

n Teeth one-rowed, 5—5; a notch on shoulder girdle below, inside gill opening; scales large.

o Snout very blunt, rounded; mouth inferior. *Biwia*, 11.

oo Snout long; mouth small, terminal, nearly vertical........ *Pseudorasbora*, 12.

nn Teeth two-rowed; 2, 5—4, 5, or 6, 2 or 1.

p Lateral line straight; teeth 2, 5—5, 2; mouth terminal, very oblique; scales large, about 40. *Otakia*, 13.

pp Lateral line curved downward.

q Dorsal fin inserted in advance of ventrals; scales small, about 75; dorsal fin short; teeth 2, 5—6, 2 .... *Tribolodon*, 14.

qq Dorsal inserted behind ventrals; teeth 2, 4 or 5—5, 2 or 1.

r Lateral line complete .... *Leuciscus*, 15

rr Lateral line incomplete; teeth 2, 5—4 or 5, 2 .... *Phoxinus*, 16

nnn Teeth three-rowed.

s Abdomen behind ventrals, its edge rounded, as usual; anal in male elevated.

t Upper jaw normal, without deep notch; teeth 1 or 2, 4, 4 or 5—5, 4, 2 or 1. Scales 40 to 60 .... *Zacco*, 17

tt Upper jaw produced, with a deep notch; teeth 2, 4, 5—5, 4, 2. Scales about 50 .. *Opsariichthys*, 18

ss Abdomen behind ventrals, compressed to an edge; before ventrals rounded; anal elongate of 15 rays; first dorsal ray more or less enlarged and spine-like; teeth 2, 4, 5—5, 4, 2; scales small, about 70 ...... *Ischikauia*, 19

aa CYPRININÆ. Dorsal fin many-rayed, preceded by a strong, serrated spine; anal spine present; teeth molar.

u Barbels none; teeth 4—4, one-rowed .. *Carassius*, 20

uu Barbels two on each side; teeth three-rowed, 1, 1, 3—3, 1, 1 ... *Cyprinus*, 21

1. PSEUDOPERILAMPUS Bleeker.

Pseudoperilampus BLEEKER, Versl. Med. Ak. Vet. Amst., XV, 1863, p. 235, (*typus*).

Body short, deep, and rhomboid. Head small, and the upper profile concave over the eyes; eye large; snout bluntly pointed; mouth small, oblique; no barbels; teeth 5—5, the sides serrate; interorbital space broad. Intestine long. Peritoneum black. Scales small, and very narrowly imbricated, about 55 in lateral line. Origin of dorsal nearer base of caudal than tip of snout, its base rather long, with 10 developed rays; anal with 10 developed rays; caudal emarginate; ventrals inserted before dorsal. Lateral line nearly straight and continuous.

Herbivorous fishes of the Japanese streams and lakes, resembling the bream (*Abramis*).

(ψευδης, false; *perilampus*, a related genus.)

1. PSEUDOPERILAMPUS TYPUS Bleeker.

ZENITANAGO (COIN-MINNOW); NIGABUNA (BITTER CARP).

Pseudoperilampus typus BLEEKER, Versl. Ak. Vet. Amst., XV, p. 235; Tokyo; Ned. Tyds. Dierk. I, p. 382.—GÜNTHER, Cat. Fish., VII, 1868, p. 281; from Japan, same type.

Pseudoperilampus sp. ISHIHAWA, Prel. Cat., 1897, p. 12; Tokyo, Tegauma.

Head, $3\frac{3}{4}$; depth, $2\frac{1}{2}$; D. III, 10; A. III, 10; P. 12; V. 8; scales, 55 in the lateral line; 12 scales between origin of dorsal and lateral line.

and 10 between the latter and middle of belly; pharyngeal teeth 5–5; width of head, $1\frac{2}{3}$ in its length; snout, $4\frac{2}{5}$ in head; eye, $3\frac{1}{2}$; interorbital space, $2\frac{1}{2}$; pectoral, $1\frac{2}{5}$; ventral, $1\frac{2}{3}$.

Body rather short, deep, rhomboid, and compressed. Head small, compressed and bluntly pointed; upper profile of head concave over the eyes; snout less than eye, rounded above and bluntly pointed; eye rather large, anterior; mouth small, oblique, the maxillary protractile and reaching below the nostrils, but not to the anterior edge of eye; lips rather thin; pharyngeal teeth compressed, with a narrow grinding surface; the sides serrate, and the tips slightly hooked; nostrils close together on the snout in front of eye; interorbital space and top of head broad and slightly convex. Gill openings rather large; gill-rakers small and weak; pseudobranchial present. Intestine long, with many convolutions. Peritoneum black.

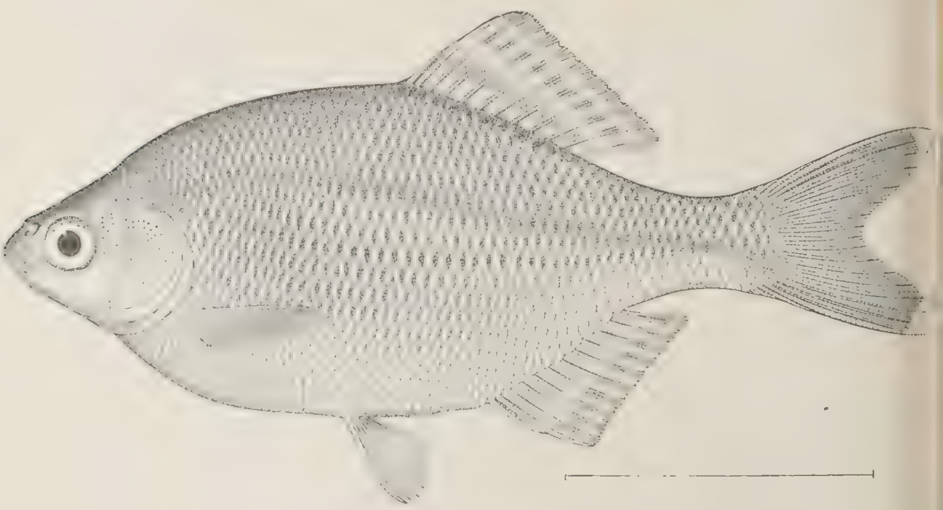


FIG. 1.—PSEUDOPERILAMPUS TYPUS.

Scales rather small, and all more or less very narrowly imbricated, so that they are much deeper than long; no pectoral flap; ventral flap present.

Origin of dorsal nearer base of caudal than tip of snout, the anterior rays the highest, the base of the fin about equal to the head, and the third rudimentary ray stronger than the others; anal beginning about midway between origin of pectoral and base of caudal, or a little before the middle of base of dorsal, and its base a trifle more than head without snout; caudal emarginate, the lobes pointed; pectoral reaches to within a short distance of ventral; origin of ventral well before that of the dorsal, or nearer tip of snout than base of caudal, and reaching within a short distance of origin of anal. Caudal peduncle compressed, and its least depth a little over 2 in head. Lateral line slightly decurved and continuous.

Color in alcohol, dark brown above, pale or silvery below, and each of the scales above and on the sides with a narrow brown margin, forming a reticulated appearance; top of head and snout dark brown; dorsal and anal grayish, with 2 longitudinal pale or whitish bands; caudal and pectoral grayish; ventrals pale; sides with a pale lateral streak, becoming more distinct and darker along the sides of caudal peduncle; a dark blotch above and behind gill-opening.

Length $2\frac{1}{8}$ inches.

This description from a specimen from Tsuruga.

This species is represented in our collection by many examples from Tsuruga in Echizen, Tsuchiura near Tokyo, Matsushima in Rikuzen, and the Tokyo market. It is generally common in the streams of northern Japan. From the species of *Acheilognathus* it is readily distinguished by its small scales.

(τυπός, type.)

2. PARACHEILOGNATHUS Bleeker.

Paracheilognathus BLEEKER, Atlas Ichth., III, 1863, p. 33 (*rhombeus*).

Body short, deep and rhomboid. Head small; eye moderate; snout pointed and slightly projecting; mouth small, inferior, the maxillary not reaching eye; a small maxillary barbel, generally less than half the eye; teeth 5–5, the edges serrate; interorbital space broad. Intestine long. Peritoneum dark or blackish. Scales large, some of those on the sides strongly imbricated, 37. Origin of dorsal midway between tip of snout and base of caudal, base of fin long, with 14 developed rays; anal with 10 developed rays; caudal deeply emarginate; ventrals inserted a little before origin of dorsal. Lateral line slightly decurved, and continuous. Short, deep-bodied fishes of the rivers of Japan.

(ηαρά, near; *acheilognathus*.)

2. PARACHEILOGNATHUS RHOMBEA (Schlegel).

TABIRA (SHINER); AKABABIRA (RED-SHINER); BOTE TANAGO[a] (POTBELLY).

Capoeta rhombea SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 205, pl. c, fig. 6; streams near Nagasaki.

Acheilognathus rhombeus BLEEKER, Prodr. Cypr., 1860, p. 255.

Paracheilognathus rhombeus BLEEKER, Atl. Ichthyol. Cypr., 1863, p. 33.

Achilognathus rhombeus GÜNTHER, Cat. Fish, VII, 1868, p. 279; Nagasaki, from one of Schlegel's types.—ISHIKAWA, Prel. Cat., 1897, p. 12; Tokyo, Lake Biwa, Yamashiro.

Achilognathus steenackeri SAUVAGE,[b] Bull. Soc. Philom. Paris, 1883, p. 3; Lake Biwa.

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[a]The name *Tanago* is used alike for the deep-bodied shiners and for the surf-fish, *Ditrema temmincki*.

[b]The following is the description given by Dr. Sauvage:

"D. 14-15; A. 11-12; L. lat. 38. Hauteur du corps contenue près de trois fois et demie dans la longueur totale; longueur de la tête cinq fois et un tiers dans la même

Head, $4\frac{1}{4}$; depth, $2\frac{1}{4}$; D., II, 14; A., III, 10; P., 14; V., 8; scales, 37 in lateral line; 6 scales between origin of dorsal and lateral line, and 7 scales between latter and middle of belly; pharyngeal teeth, 5—5; width of head, $1\frac{3}{5}$ in its length; snout, 4 in head; eye, 4; interorbital space, $2\frac{1}{2}$; pectoral, $1\frac{1}{3}$; ventral, $1\frac{4}{7}$.

Body deep, rhomboid, and greatly compressed. Head short and compressed; snout pointed, convex above, and slightly projecting beyond the jaws; eye moderate, anterior about equal to snout; mouth small, inferior, and protractile, the maxillary not reaching as far posteriorly as the front margin of eye; lips somewhat fleshy; a small maxillary barbel generally less than half the eye; pharyngeal teeth serrated, and hooked over at tips; nostrils together, nearer eye than tip of snout; interorbital space broad, elevated a little, and flattened in the middle. Gill openings large; gill rakers short, weak, and rather few in number; pseudobranchiæ well developed. Intestine very long, and with numerous convolutions. Peritoneum dark or blackish.

Scales large, cycloid, and some on the middle of the sides strongly imbricated; no pectoral flap; ventral flap rather short.

Origin of dorsal about midway in the length of the body without caudal, the anterior rays the highest, the base of the fin a little over 3 in body without caudal, the third rudimentary ray as long as first developed ray, thick and strong, and the margin of the fin convex; origin of anal about midway in the base of dorsal, or the space between the origin of ventral and base of last anal ray, the anterior rays the highest, the base of the fin equal to head without snout, and the margin of the fin nearly straight; caudal deeply emarginate, the lobes pointed; pectorals rather small, low, and reaching two-thirds the distance to origin of ventrals; ventrals inserted a little before the origin of dorsal and reaching almost to origin of anal. Caudal peduncle moderately long, and its least depth 2 in head. Lateral line continuous and nearly straight along the sides to base of caudal.

Color in alcohol, dark brown above, the scale edged with darker; below pale, washed with silvery; sides more or less brassy; a dark, blackish streak, narrow at first and becoming wider posteriorly along the sides, continued along the caudal peduncle, but not to the base of

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dimension. Museau aussi long que l'œil, dont le diamètre est compris trois fois et demie dans la longueur de la tête; espace interorbitaire plus large que le diamètre de l'œil; barbillons très courts; dents pharyngiennes non dentelées; de gros pores autour de la partie supérieure de l'œil et sur le museau chez les mâles, nuls chez les femelles. Dorsale insérée à égale distance du museau et de la base de la caudale chez les femelles, un peu plus près de la base de la caudale chez les mâles; pectorales s'étendant à l'origine des ventrales chez les femelles, un peu plus courtes chez les mâles. Corps de couleur argenté; chez les femelles une bande cérulescente sur le pédicule caudal; chez les mâles des lignes cérulescentes longitudinales dans la partie posterieure du corps. Un long tube externe urogénital chez les femelles. Longueur, 0, 100. Nom vulgaire, *Funa; Akababira.*

the caudal; a dark spot above the gill opening; dorsal and caudal dark or blackish with indistinct narrow bands, the other fins paler, but all of them more or less tinted with brownish.

Color in life, steel blue; sides bright crimson, with silver luster; two blue bars at shoulder; belly and lower fins crimson, with dark shades.

Length, 4 inches.

This description from a specimen from Lake Biwa at Matsubara. Of this species we have very many specimens from Matsubara on Lake Biwa, from the Yodo River at Osaka, from the Chikugo River at Kurume, from the springs of Funayado in Kiusiu, Lake Yogo near Wakanogo, above Lake Biwa, and several examples from the collection of K. Otaki, from near Karasaki on Lake Biwa. It is the largest of the minnows of its tribe, and is almost everywhere common south of Tokyo, in the larger streams and ponds. In life it is brightly colored, the fins largely red.

(*ῥόμβος*, diamond.)

3. ACHEILOGNATHUS Bleeker.

Acheilognathus BLEEKER, Ichth. Archipel. Indic. Prodr., II, 1860, p. 228 (*melanogaster*).

Body more or less deep and compressed; head short; eye more or less large; snout rather short and blunt; mouth small, the maxillary not reaching the eye; maxillaries each with a barbel; teeth 5—5, smooth, with a narrow grinding surface; interorbital space rather broad. Intestine long. Peritoneum black. Scales large, some of those on the sides imbricated, 36 to 39. Origin of dorsal about midway in the length of body without caudal, base of fin moderate, with 8 to 10 developed rays; anal with 8 to 10 developed rays; caudal deeply emarginate; ventrals generally inserted a little before origin of dorsal. Lateral line slightly decurved, and continuous.

Small fishes of the streams and lakes of Japan, Formosa, and China, differing from *Paracheilognathus* in the shorter dorsal and smooth edged teeth.

(*ἀ*, without; *χεῖλος*, lip; *γνάθος*, jaw.)

a Shoulder with a more or less distinct, dark shoulder spot above gill-opening; sides with a more or less distinct longitudinal band posteriorly; belly black in adults, the color of the peritoneum showing through.
  b Barbels short, seldom more than half the eye; shoulder spot and lateral band very distinct .... *limbata*, 3.
  bb Barbels long, somewhat less than the eye; shoulder spot and lateral band very indistinct or absent .... *lanceolata*, 4.
aa Shoulder without dark spot above gill opening; a longitudinal dark band beginning abruptly in a dark blue spot over pectoral on the sixth scale from head and continued to base of caudal .... [illegible]

3. ACHEILOGNATHUS LIMBATA (Schlegel).

ZAKO; TANAGO.

Capoëta limbata SCHLEGEL, Fauna Japonica, Poiss, 1846, p. 203, pl. c, fig. 5; Streams near Nagasaki.

Achilognathus limbatus GÜNTHER, Cat. Fish., VII, 1868, p. 277; Nagasaki, from one of Schlegel's types.

Acheilognathus intermedium JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 344; Lake Biwa (not of Schlegel).

Head 4; depth 3; D. III, 10; A. III, 10; P. 15; V. 8; scales 36 in lateral line; 6 scales between origin of dorsal and lateral line, and 6 scales between the latter and middle of belly; pharyngeal teeth 5—5; width of head $1\frac{3}{4}$ in its length; snout 4 in head; eye 3; interorbital space $2\frac{3}{4}$; pectoral $1\frac{1}{6}$; ventral $1\frac{1}{2}$.

Body rather elongate, moderately deep, and compressed. Head short, and compressed; snout short, rather blunt and not produced; eye rather large, anterior; mouth small, oblique, and reaching below the nostril; maxillary protractile, and furnished with a small barbel which is seldom more than half the eye in length; pharyngeal teeth with a narrow grinding surface, smooth, and without serrations; nostrils close together, and near the upper part of the eye; interorbital space rather broad, slightly elevated and flattened medianly. Gill-openings rather large; gill rakers short, weak, and few in number; pseudobranchial present. Intestine with numerous convolutions. Peritoneum black.

Scales large, cycloid, and narrowly imbricated in the costal region; no pectoral flap; a short, scaly, ventral flap.

Origin of dorsal about midway, or a trifle in advance, in the length of the body without caudal, the anterior rays the highest, the base of the fin about $4\frac{1}{3}$ in body without caudal, the third rudimentary ray as long as first developed ray and rather strong, and the margin of the fin straight; origin of anal below the middle, or a trifle posterior, base of dorsal much nearer the origin of ventral than base of last anal ray, similar to dorsal in shape, with the anterior rays the highest, the base of the fin less than head without snout, and the margin of the fin nearly straight; caudal very deeply emarginate, the lobes well developed and pointed; pectorals equal the head from anterior nostril to edge of opercle, and reach to within a short distance of the origin of the ventrals; ventrals slightly in front of the origin of the dorsal, and reaching beyond the origin of the anal. Caudal peduncle rather long, its least depth $2\frac{1}{4}$ in head. Lateral lines nearly straight, and continuous along the sides to the base of caudal.

Color in alcohol, dark brown above, tinged with olivaceous, and below paler, except the abdomen, which is black; a narrow blackish streak beginning on the sides in front above the lateral line, and is continued to within a short distance of the base of the caudal, becom-

ing much wider upon the sides of the caudal peduncle; a dark spot above gill-opening; dorsal grayish, with 3 darker longitudinal bands; caudal grayish, with several darker cross bands; pectorals grayish; ventrals and anal black, with white edges; lower surface of the head pale or whitish.

Length, 3 inches.

This description from a specimen from Lake Yogo in Mino, above Lake Biwa.

Fresh waters of central and southern Japan, very abundant. We have a very numerous series from Lake Biwa at Matsubara and Karasaki, from the river at Tsuchiura, the Iwai River at Ichinoseki, from near Nagoya, and the Kitakami River at Morioka.

It is the only species of the group common in northern Japan. It is known by its more elongate form, as contrasted with *Paracheilognathus rhombea*, though with a similar color pattern, with the addition of a black abdomen, and dark pectorals, and ventrals, in some adults. The dorsal radii are fewer than those of *P. rhombea* and the pharyngeal teeth are smooth.

(*limbatus*, bordered.)

4. ACHEILOGANTHUS LANCEOLATA (Schlegel).

ZAKO.

Capoëta lanceolata Schlegel, Fauna Japonica, 1846, p. 202, pl. c, fig. 3; streams about Nagaski.

Acheilognathus lanceolatum Jordan and Snyder, Proc. U. S. Nat. Mus., XXIII, 1901, p. 344; Lake Biwa.

Acheilognathus melanogaster Bleeker, Act. Soc. Sci. Indo. Nedrl. Japan, VI, p. 92, pl. ii, fig. 1; Tokyo.—Sauvage, Bull. Soc. Philom., 1883, p. 3; Lake Biwa.—Günther, Cat. Fish, VII, 1868, p. 278; Tokyo, from one of Bleeker's types.—Ishikawa, Prel. Cat., 1897, p. 12; Lake Biwa, Owari.—Günther, Shore Fishes, Challenger, 1880, p. 72; Lake Biwa.

Capoëta intermedia Schlegel, Fauna Japonica, p. 203, pl. c, fig. 4; streams about Nagasaki.

Acheiloganthus intermedius Günther, Cat. Fish, VII, 1868, p. 278, copied.—Sauvage, Bull. Sci. Philom., 1883, p. 3; Lake Biwa.—Ishikawa, Prel. Cat., 1897, p. 12; Tokyo; Yodo R. at Kyoto; Maebara and Matsubara on Lake Biwa.

Head $4\frac{1}{4}$; depth 3; D. III, 9; A. III, 9; P. 15; V. 8; scales 38 in the lateral line; 6 scales between the origin of the dorsal and the lateral line; and 6 scales between the latter and middle of belly; pharyngeal teeth 5—5; width of head $1\frac{3}{4}$ in its length; snout $4\frac{1}{4}$ in head; eye $3\frac{1}{4}$; interorbital space $2\frac{2}{3}$; pectoral about $1\frac{2}{5}$; ventral $1\frac{1}{2}$.

Body rather elongate, moderately deep and compressed. Head short, compressed; snout short and bluntly rounded; eye moderately large, anterior; mouth small, oblique, the maxillary reaching to the nostril, and protractile; maxillary barbel long, but little shorter than the eye; pharyngeal teeth smooth, and with a narrow grinding surface; nostrils close together in front of the eye above; interorbital

space broad, slightly elevated, and flattened in the middle. Gill-openings rather large; gill rakers short, weak and few in number; pseudobranchiæ well developed. Intestine with numerous convolutions. Peritoneum black.

Scales large, cycloid, and some narrowly imbricated on the sides; no pectoral flap; ventral flap small.

Origin of dorsal about midway, or a trifle in advance, in the length of the body, without caudal, the anterior rays the highest, the base of the fin $1\frac{1}{2}$ in body without caudal, the third rudimentary ray more or less stiff and strong, and the margin of the fin nearly straight; origin of anal below the posterior dorsal rays, and about midway between the origin of ventrals and base of last anal ray, similar in shape to the dorsal, the anterior rays the highest, the base of fin less than head without snout, the third rudimentary ray stiff, and the margin of the fin nearly straight; caudal deeply emarginate, the lobes pointed; pectorals reach a little over two-thirds the distance to origin of ventrals; ventrals inserted a little before origin of dorsal and reaching to within a short distance of origin of anal. Caudal peduncle rather long and its least depth about $2\frac{1}{4}$ in head. Lateral line slightly decurved, and continued to base of caudal.

Color in alcohol, dark brown above, pale below, except the abdomen and ventrals, which are blackish; a very pale and indistinct brown spot above gill-opening, and a pale, indistinct brown or grayish stripe along the sides above the lateral line, and posteriorily; dorsal and anal grayish, with several longitudinal dark bands across the former, and the latter broadly edged with whitish; caudal and pectorals grayish.

Length, $3\frac{5}{16}$ inches.

Here described from an example from Tsuchiura.

The species is very abundant in central and southern Japan. Our many examples from Tsuchiura, the Chikugo River at Kurume, the Yodo River at Osaka, Lake Biwa at Matsubara, Katata in Omi, Lake Yogo in Mino, Funayado in Kiusin, Wakanoura, in Owari near Nagoya.

This species is distinguished chiefly by its long barbel and plain coloration. The young are marked with a more or less distinct lateral stripe, but are without a dark spot above the gill opening.

(*lanceolata*, lanceolate.)

5. ACHEILOGNATHUS CYANOSTIGMA Jordan and Fowler, new species.

Head, 4; depth, $3\frac{1}{16}$; D. III, 8; A. III, 8; P. 16; V. 8; scales, 39 in lateral line; 6 scales between origin of dorsal and lateral line, and 6 scales between the latter and middle of belly; pharyngeal teeth 5—5; width of head, 2 in its length; snout, $3\frac{3}{5}$ in head; eye, 4; interorbital space, $2\frac{2}{3}$; pectoral, $1\frac{1}{2}$; ventral, $1\frac{2}{3}$.

Body moderately deep, and compressed. Head rather small, compressed; snout rather bluntly pointed and a trifle produced; eye small,

anterior; mouth small, inferior; maxillary short, reaching to the nostril and protractile; maxillary barbel very short; pharyngeal teeth smooth, and with a narrow grinding surface; nostrils close together and near the upper part of the eye; interorbital space rather broad, slightly elevated and flattened medianly. Gill-openings rather large; gill-rakers short, few, and weak; pseudobranchiæ present.

Intestine with numerous convolutions. Peritoneum black.

Scales moderately large, cycloid, and some of them imbricated on the sides; no pectoral flap; ventral flap small.

Origin of dorsal about midway in the body without caudal, the anterior rays the highest, the base of the fin about 5 in body without caudal, and the upper edge of the fin nearly straight; origin of anal below the posterior dorsal rays or about midway between origin of ventral and base of last anal ray, the anterior rays the highest, the base of the fin about 5 in body without caudal, and the upper edge of the fin nearly

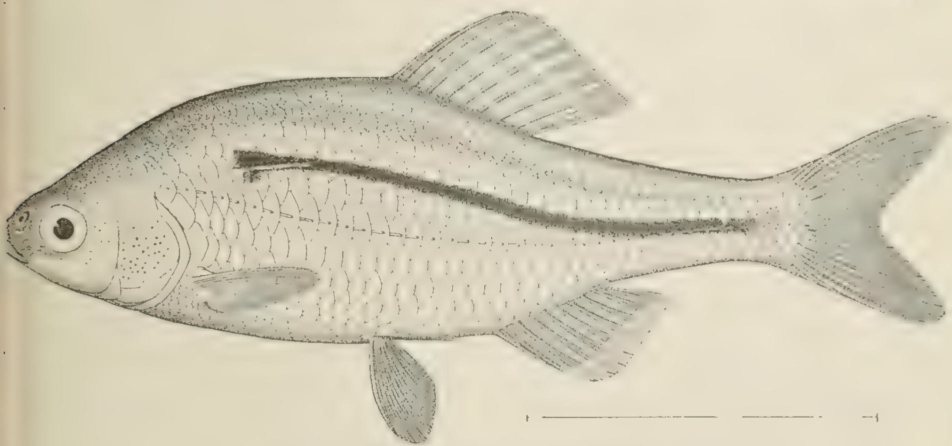


FIG. 2.—ACHEILOGNATHUS CYANOSTIGMA.

straight; origin of anal below the posterior dorsal rays or about midway between origin of ventral and base of last anal ray, the anterior rays the highest, the base of the fin $1\frac{4}{5}$ in head, and the margin of the fin nearly straight; caudal deeply emarginate and the lobes pointed; pectorals reaching about two-thirds of the distance to origin of ventrals; ventrals inserted below the origin of the dorsal, and reaching the origin of the anal. Caudal peduncle rather long, a trifle shorter than head, and its least depth about $2\frac{1}{2}$ in head. Lateral line slightly decurved and continued to the base of caudal.

Color in alcohol, brownish above, pale beneath; dorsal and caudal grayish black, the former with several darker longitudinal cross bars; anal grayish, with a broad marginal, whitish band; pectorals grayish; ventrals grayish black; snout dark brown; sides with a longitudinal, blackish band beginning abruptly in a black spot on the upper part of the sides about over the middle of the pectoral, and on the sixth scale from the head; no dark spot above gill opening.

Length, $2\frac{3}{4}$ inches.

Type No., 7724, Ichthyological Collections, Leland Stanford Junior University Museum. Cotypes are in the United States National Museum. Locality, Lake Biwa at Matsubara in Omi.

We have many specimens of this species from Lake Biwa at Matsubara and its tributary, Lake Yogo in Mino. It is distinguished chiefly by the dark, distinct, and nearly uniform lateral stripe beginning on the sixth scale from the head in a dusky bluish spot. In young specimens, the character is readily seen, and they are easily separated from the young of other species.

(κυανεός, blue; στίγμα, spot.)

4. GNATHOPOGON Bleeker.

Gnathopogon Bleeker, Ichth. Archipel. Indic. Prodr., II, 1860, p. 434 (*elongata*).

Body elongate and compressed. Snout depressed and without bony prominence in front; eyes superior, not covered with eyelids; jaws with thin and simple lips; maxillary oblique, ending before the eye; two maxillary barbels. Abdomen not keeled. Dorsal with few rays before ventrals and ending in front of anal; anal with few rays. Lateral line slightly decurved. (Bleeker.)

No species of *Gnathopogon* was obtained by Jordan and Snyder. The genus is a doubtful one, perhaps not distinct from *Acheilognathus*. An East Indian species, *javanicus*, is referred by Dr. Bleeker to *Gnathopogon*.

(γνάθος jaw; πογών, beard.)

a Scales 5—38—7: pectorals not reaching root of ventrals .... *elongatus*, 6.
aa Scales 4—35—5: pectorals reaching ventrals .... *gracilis*, 7.

6. GNATHOPOGON ELONGATUS (Schlegel).

MUGITSUKI.

Capoëta elongata Schlegel, Fauna Japonica, Poiss., 1846, p. 200, pl. c, fig. 1; streams about Nagasaki.

Gnathopogon elongatus Jordan and Snyder, Check List Fish. Japan, 1901, p. 47; Lake Biwa.

Barbus homogenes Günther, Cat. Fish., VII, 1868, p. 136 (after Schlegel, the name *elongatus* being preoccupied in *Barbus*).

Head 4 in length of body, between tip of snout and emargination of caudal, and somewhat more than depth of body; D. III, 7; A. II, 6; P. 15; V. I, 7; about 38 scales on the lateral line; 5 scales between the back and the lateral line; diameter of the eye equal to the length of snout, which is 4 in head. Mouth somewhat spacious, its cleft very oblique, and extending nearly to the tip of the snout; maxillary prolonged posteriorly for three-fourths the length of the snout; diameter of the suborbitals equal a third of the eye, but the length of the posterior nearly twice that of the others; length of maxillary barbel

scarcely exceeding half the diameter of the eye; nostrils only separated by a thin lobe which covers the posterior orifice, opening upon the lower sides of the snout midway between the intermaxillary and the eye; interorbital space considerably more than the diameter of the eye. The edge of the opercle forms a somewhat obtuse and rounded angle. Upper part of the head rounded upon the sides; its upper profile straight until the snout, which is somewhat convex. Line of demarcation between head and neck nearly straight; the skin of head and opercles smooth.

Scales with their surfaces marked with fine striae, very compact and somewhat divergent.

Insertion of dorsals slightly before the ventrals and nearer the head, the second and third rudimentary rays like the first and second of the anal, but the size of the fins a third larger than the latter; margin of anal straight, equals, or somewhat more than ventrals, and preceded by a weak spine less than half the length of the slender and flexible ray which follows, and which is also longer than the first divided ray of the fin; caudal emarginate, lobes pointed, and their length about half the fin; pectorals equal to head without snout and not reaching to base of ventrals by a space equal to half their own length; ventrals a fifth shorter than pectorals and almost reach the anus. Anus entirely after the origin of the anal and about two-thirds of the distance between tip of snout and base of caudal.

Color in spirits brown above with silvery reflections, below pale; opercles pure silvery white and the fins uniform yellowish; scales sprinkled with numerous minute black dots; a broad and ill-defined band of bluish-silvery extending along the sides of the body.

Two specimens, one 3 inches and the other $3\frac{1}{2}$ inches in length, taken in some stream near Nagasaki. (Schlegel.) The specimen taken by Otaki at Karasaki on Lake Biwa has been sent away.

(*elongatus*, elongate.)

7. GNATHOPOGON GRACILIS (Schlegel).

Capoëta gracilis Schlegel, Fauna Japonica, Poiss., 1846, p. 201, pl. c, fig. 2; streams near Nagasaki.

Barbus homozonus Günther, Cat. Fish., VII, 1868, p. 137, after Schlegel, the name *gracilis* preoccupied in *Barbus*.

Form elongate; depth $5\frac{1}{2}$ in the length of the body between tip of snout and emargination of caudal. Body posterior to dorsal slender. Head longer; eyes much larger; snout bulky and convex above; mouth cleft horizontal. Suborbitals narrower; barbels somewhat longer; pectorals very long and reaching nearly to the base of the ventrals; lateral line slightly decurved; anus remote from the anal fin; the scales much larger, only 25 in the lateral line; 4 rows of scales between lateral line and back and 5 rows between the former and the

abdomen. The form of the fins and the number of their rays, the color, and all the other characters, are common with *Gnathopogon elongatus*.

Length $2\frac{1}{2}$ inches. (Schlegel.)

From a stream near Nagasaki; perhaps identical with *Gnathopogon elongatus*.

(*gracilis*, slender.)

5. HEMIBARBUS Bleeker.

Hemibarbus BLEEKER, Prodr. Cyprin., 1861, p. 281 (*barbus*).

Body elongate, rather slender, and compressed. Head elongate, somewhat pointed, and with many mucous cavities about the eyes and along the edge of the preoperculum; snout long, blunt at the tip; eye rather large, high; mouth inferior, the maxillary not reaching eye; lips fleshy; each maxillary with a barbel as long as the eye; teeth 5, 3, 1—1, 3, 5. Gill-rakers short; intestine short. Peritoneum silvery; scales cycloid, about 49. Dorsal inserted nearer tip of snout than base of caudal, and armed with a slender, sharp, strong, and smooth spine; anal inserted far behind tip of depressed dorsal; caudal deeply emarginate, the lobes pointed; ventrals inserted behind origin of the dorsal. Lateral line slightly decurved and continuous.

Large fishes of the streams of Japan and Formosa, allied to the European Barbel (*Barbus barbus*).

(ἥμι, half; *barbus*.)

8. HEMIBARBUS BARBUS (Schlegel).

SOI, NIGOI.

Gobio barbus TEMMINCK and SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 198, pl. XCIX, fig. 1; near Nagasaki.

Hemibarbus barbus BLEEKER, Prodr. Cypr., 1861, p. 281.—JORDAN and SNYDER, Check List Fish. Japan, 1901, p. 46; Yokohama.—JORDAN and EVERMANN, Proc. U. S. Nat. Mus., 1902; Formosa.

Barbus schlegeli GÜNTHER, Cat. Fish., VII, 1868, p. 134; Formosa.—ISHIKAWA, Prel. Cat. 1897, p. 15; Tokyo, Ise.

Head $3\frac{2}{7}$; depth $4\frac{1}{2}$; D. III, 7; A. III, 6; P. 20; V. 9; scales 49 in the lateral line; 7 scales in an oblique series between origin of dorsal and lateral line, and 7 scales between the latter and middle of belly; pharyngeal teeth 5, 3, 1—1, 3, 5; width of head $2\frac{1}{4}$ in its length; snout $2\frac{2}{7}$ in head; eye 5; interorbital space $3\frac{3}{4}$; pectoral $1\frac{1}{2}$; ventral $1\frac{7}{8}$; eye 2 in snout.

Body elongate and compressed. Head elongate, pointed, greatly compressed, with many mucous cavities around the eyes, and below and behind the edge of the preoperculum; snout long, pointed, and produced; eyes moderately large, anterior and superior; mouth small, inferior, and with the upper jaw produced; lips fleshy and not broad; a slender maxillary barbel equal to the diameter of the eye; pharyn-

geal teeth in 3 rows, several with grinding surface, and compressed, and those in the inner row small; nostrils together, in front of the eye and about over the base of the maxillary barbel so that they are much nearer the eye than the tip of the snout; interorbital space broad and flattened like the rest of the top of the head. Gill openings large; gill-rakers 7—12, some of the lower ones rudimentary; those which are well developed short and fleshy. Intestine short. Peritoneum silvery.

Scales large, of more or less uniform size, and cycloid; no scaly pectoral flap; ventral flap moderate.

Dorsal fin inserted nearer the tip of the snout than the base of the caudal, armed with a long, straight, smooth spine, the anterior dorsal rays the longest, so that when the fin is depressed the first reaches beyond the others; anal entirely behind dorsal and midway between the origin of the ventrals and the base of the caudal; caudal deeply forked, the lobes pointed; pectorals reach three fourths the distance to the ventrals; origin of ventrals behind that of dorsal, about midway between tip of snout and base of caudal, and reaching a little more than half the space to anal; caudal peduncle compressed, its least depth a little over 3 in head. Lateral line continuous and slightly decurved in front.

Color in alcohol, brassy-brown above, the sides and lower surface silvery.

Length, 9¾ inches.

This description from an example from the Yodo River, in Osaka.

Fresh waters of Japan. Of this species we have examples from Lake Jinsaburogata at Nishitsugaru, Aomori (collection Sotaro Saito), the Yodo River at Osaka, the Chikugo River at Kurume, and from near Tokyo (*Albatross* collection).

(*barbus*, the European barbel.)

6. LEUCOGOBIO Günther.

Leucogobio Günther, Ann. Ac. Sci. Pétersburg, 1896, p. 212 (*herzensteini*).

Body oblong, slightly compressed. Head elongate; eye moderate; snout not projecting; mouth oblique, the jaws about equal, and the lips narrow and simple; the maxillary barbel sometimes as long as the eye; teeth 6 or 5 and 3, 2 or 1—6 or 5—5—3, 2 or 1; interorbital space broad; nostrils close together. Intestine short. Peritoneum generally silvery. Scales large, cycloid, and not imbricated. Dorsal inserted midway or in advance of space between tip of snout and base of caudal; caudal emarginate. Lateral line nearly straight or only slightly decurved and continuous. This genus is related to *Gobio*, differing in its mouth, which is like that of *Leuciscus*. It embraces two Chinese species, *Leucogobio herzensteini* and *Leucogobio tæniatus*, and four Japanese species.

(λευκός, white; gobio.)

a Dorsal generally inserted midway between the tip of the snout and the base of the caudal; young with a black spot at base of caudal.

b Body deep; caudal emarginate; sides with longitudinal brown bands. *güntheri*, 9.

bb Body more elongate; caudal very deeply emarginate; a bluish-black lateral band . . . . *jordani*, 10.

aa Dorsal always inserted much nearer the tip of the snout than the base of caudal; young without black caudal spot; coloration more or less silvery.

c Body deep; eye 4 in head; color silvery . . . . *mayedæ*, 11.

cc Body elongate, rather slender; eye a little over 3 in head, above with a few brown spots . . . . *biwæ*, 12

9. LEUCOGOBIO GÜNTHERI Ishikawa.

Leucogobio güntheri ISHIKAWA, Annot. Zool. Japon., III, Pt. 4, April 30, 1901; p. 161; Maibara, Matsubara, etc., on Lake Biwa.

Head $3\frac{3}{5}$; depth $3\frac{3}{4}$; D. III, 7; A. III, 6; P. 15; V. 8; scales 38 in the lateral line; 6 scales in an oblique series between origin of dorsal and lateral line, and 6 scales between the latter and middle of belly; pharyngeal teeth 5, 3—3, 5; width of head $1\frac{4}{5}$ in its length; snout $3\frac{1}{2}$ in head; eye $4\frac{1}{2}$; interorbital space $2\frac{7}{8}$; pectoral $1\frac{3}{5}$; ventral $1\frac{2}{3}$.

Body moderately elongate, compressed, and rather deep. Head elongate, and pointed bluntly; snout bluntly rounded, a little longer than the eye and not projecting beyond the mandible; eyes anterior, moderately large, and $1\frac{1}{3}$ in snout; mouth rather large, oblique, so that the jaws meet in front on a level with the middle of the eyes and the maxillary reaches behind nearly to the front margin of the eye; lips somewhat broad and fleshy; a slender maxillary barbel about equal to the eye; pharyngeal teeth in 2 rows, several of the larger ones with grinding surface and those in the inner row small; nostrils together, in front and nearer the eye than tip of snout; interorbital space broad and slightly convex. Gill-openings large; gill-rakers short, and weak; pseudobranchiæ large; gill-filaments long. Intestine short. Peritoneum silvery.

Scales large, of more or less uniform size, and cycloid; no pectoral flap; ventral flap present.

Origin of the dorsal in most cases midway between the tip of the snout and the base of the caudal, though when depressed not reaching over the origin of the anal; origin of the anal nearer that of the ventral than base of caudal, and when depressed reaching more than half way to the latter; caudal emarginate; pectoral about three-fifths of space to ventral; origin of ventral about under that of dorsal, and the fin reaching three-fifths the distance to anal. Caudal peduncle compressed, deep, and in its least depth 2 in head. Lateral line continuous, nearly straight, only very slightly decurved in front.

Color in alcohol dark brassy olivaceous brown above, and below pale or whitish with silvery reflections; along the sides are a series of pale

longitudinal stripes following in the series of scales, and that along the lateral line very much darker than the others; at the base of the caudal a blackish spot; dorsal, caudal, and pectoral brownish, the other fins pale; lips brownish.

Length, $3\frac{5}{16}$ inches.

This description from an example from Matsubara on Lake Biwa in Omi.

Fresh waters of central Japan. Our very numerous series of specimens are from Matsubara on Lake Biwa in Omi, Nagoya in Owari, Katata in Omi, and the Chikugo River at Kurume.

From Ishikawa's description of *Leucogobio jordani* we see little to distinguish it from the present species, although we hesitate to unite the two without further material. We have also not seen any specimens with 6 teeth in the larger row.

(Named for Dr. Albert Günther.)

10. LEUCOGOBIO JORDANI Ishikawa.

Leucogobio jordani Ishikawa, Annot. Zool. Japon., III, Pt. 4, April 30, 1901, p. 163; Lake Biwa at Shiwotsu and Matsubara.

Head 3 (in total); depth 6 (in total); D. 10; A. 7; V. 8; scales in lateral line 39–40; scales transversely $5\frac{1}{2}$–$4\frac{1}{2}$; pharyngeal 6 or 5, 3–3, 5 or 6; eye $1\frac{1}{2}$ in interorbital space.

Head relatively long with the snout a little longer than the eye, which is a little less than the length of the head; mouth anterior, deeper than wide, its corner being halfway between the end of the snout and the anterior border of the eye; barbels minute, about two-thirds the diameter of the pupil. Pharyngeal teeth hooked at the end. Intestinal tract with only a single convolution. Peritoneum with a few pigments of brownish color. Number of vertebræ 33, of which 14 enter into the tail.

There are about 3 series of scales between the lateral line and the ventral fin.

Origin of the dorsal slightly in advance of the root of the ventral, and just in midway between the end of the snout and the root of the caudal; caudal fin very deeply emarginate; pectoral fin about half the length of the head, without snout and terminating a long way from the root of the ventral; ventral shorter than the pectoral and terminating in front of the vent.

Color silvery; back dark brownish, and a bluish-black band on the side of the body; a small triangular spot of a deeper color at the root of the caudal is very distinct in small individuals.

Length 78 mm. (about $3\frac{1}{16}$ inches).

Shiwotsu and Matsubara on Lake Biwa. (Ishikawa.)

This species, not seen by us, is said to differ in a marked way from *Leucogobio güntheri* by its slender form, its longer head, and its longer

and deeper emarginated caudal. According to the figure the pectoral fin is represented as nearly two-thirds the length of the head, including snout, or about equal to the space between the middle of the eye and the posterior margin of the gill-opening.

(Named for Dr. David Starr Jordan.)

11. LEUCOGOBIO MAYEDÆ (Jordan and Snyder).

Gobio mayedæ JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1900, p. 342, pl. IX, fig. 2; Lake Biwa, near Karasaki.—JORDAN and SNYDER, Check-List Fish. Japan, III, April 3, 1901, p. 46; Lake Biwa.

Head $4\frac{1}{2}$; depth $4\frac{1}{5}$; D. III, 7; A. III, 6; P. 16; V. 8; scales in lateral line 42; 5 scales between origin of dorsal and lateral line, and 6 scales between the latter and the middle of the belly; pharyngeal teeth 5, 3—3, 5; width of head a little less than 2 in its length; snout $3\frac{3}{4}$ in head; eye 4; interorbital space $3\frac{1}{2}$; pectoral $1\frac{2}{5}$; ventral $1\frac{1}{2}$.

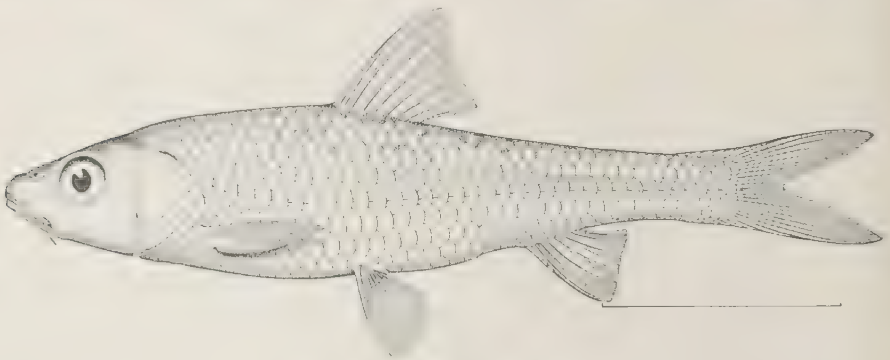


FIG. 3.—LEUCOGOBIO MAYEDÆ.

Body elongate, oblong and compressed. Head elongate, compressed; snout rather bluntly rounded, and a trifle longer than the eye; eyes moderate, anterior; mouth oblique, protractile, the jaws about equal and the maxillary not reaching to the front of the eye; lips somewhat fleshy; a small maxillary barbel; pharyngeal teeth in the larger row with narrow grinding surface, and some of them slightly hooked; nostrils close together, in front of the eye above and also a little before the end of the maxillary; interorbital space broad and slightly convex. Gill-openings large and the membrane rather broadly joined to the isthmus; gillrakers short, few, and weak; pseudobranchiæ large; gill-filaments rather long. Intestine short. Peritoneum silvery.

Scales rather large, of more or less uniform size, and cycloid; head naked; no pectoral flap and the ventrals with a well developed flap.

Origin of dorsal much in advance of the middle of the body without caudal, and the tip of the first developed ray reaching as far posteriorly as the tip of the last when the fin is depressed; origin of anal entirely behind dorsal and when the fin is depressed it does not reach quite half the distance to base of caudal; caudal deeply emarginate,

d the lobes pointed; pectoral falling rather in front of the origin of rsal, and about three-fifths of the space to ventrals; origin of venals a trifle behind the origin of the dorsal, and reaching about threeths in the space to the origin of anal. Caudal peduncle compressed. ther long, and its least depth $2\frac{1}{3}$ in head. Lateral line continuous ong the sides, and almost straight.

Color in alcohol brown, pale or whitish below, and the body more less silvery on the sides and lower parts; a pale longitudinal band, coming darker along the caudal peduncle, along the sides; fins tinted th brown, except the ventrals and anal, which are pale like the lower rface.

Length $4\frac{5}{8}$ inches.

This description from a specimen from Lake Biwa at Matsubara.

Fresh waters of southern Japan, very abundant in Lake Biwa.

Our many specimens are from near Karasaki, Lake Biwa (cotypes). o. 6272, Ichthyological collections Leland Stanford Junior Unirsity Museum (collection K. Otaki)) Lake Biwa at Matsubara and ze, the Yodo River at Osaka in Settsu, the Chikugo River at urume, and from near Nagoya in Owari.

In young examples the fins are longer, and the lateral band more stinct posteriorly but without a dark spot at the base of the caudal.

(Named for Kinichiro Mayeda, a Japanese student in Leland Stanrd Junior University.)

12. LEUCOGOBIO BIWÆ (Jordan and Snyder).

Gobio biwæ JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1900, p. 340, pl. IX, fig. 1; Lake Biwa near Matsubara.—JORDAN and SNYDER, Check List Fish. Japan, III, April 3, 1901, p. 46; Lake Biwa.

Head 4; depth about 6; D. III, 7; A. III, 6; P. 17; V. 8; scales in the lateral line; 4 scales between the origin of dorsal and lateral e, and 6 scales between the latter and middle of belly; pharyngeal eth 5, 3—3, 5; width of head 2 in its length; eye a little over 3; erorbital space $4\frac{1}{4}$; pectoral $1\frac{1}{3}$; ventral $1\frac{1}{2}$.

Body elongate, rather slender and compressed. Head elongate, comessed, and somewhat pointed in front; snout rather long, bluntly unded, and a little shorter than the eye; eyes large lateral and anteor; mouth oblique, inferior, protractile, the jaws equal, and the maxary reaching almost to the front of the eye; the jaws meet about level th the lower margin of the eye; lips somewhat fleshy; a maxillary rbel equal to about two-thirds the orbit; several pharyngeal teeth in e larger row with narrow grinding surfaces; nostrils together and ar the front of the eye; interorbital space broad and flattened. Gill enings large; gillrakers short, few, and weak; pseudobranchiæ well veloped; gill-filaments rather long. Intestine short. Peritoneum th a little dusty coloring.

Scales rather large, of more or less uniform size, and cycloid; head naked; no pectoral flap; ventral flap small.

Origin of dorsal much in advance of the middle of the body without caudal, and the tip of the first developed ray reaching as far posteriorly as the tip of the last when the fin is depressed; origin of anal behind tip of depressed dorsal a trifle nearer the origin of the ventral than base of caudal, and the fin reaching about halfway in the space between; caudal deeply emarginate and the lobes pointed; pectoral reaching almost to the origin of dorsal and about three-fourths in the space to origin of ventral; ventral behind origin of dorsal, and about three-fifths in the space to anal. Caudal peduncle compressed, rather long, and its least depth about equal to the eye. Lateral line continuous along the sides, very slightly decurved in front.

Color, in alcohol, brown, pale or whitish washed with silvery below; above the lateral line and upon the upper surface of the head with fine

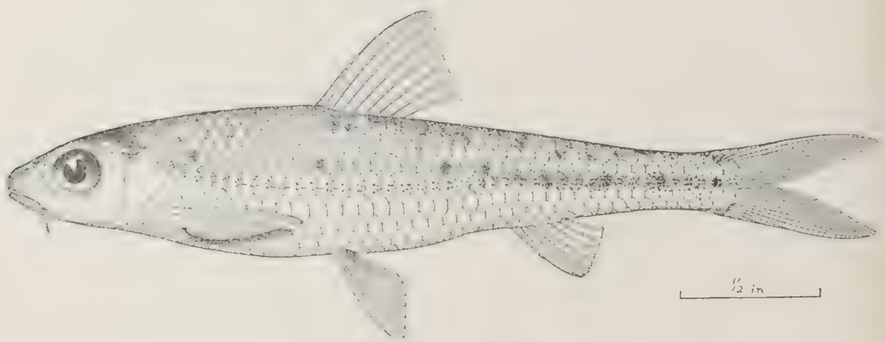


FIG. 4.—LEUCOGOBIO BIWÆ.

black dots grouped together on the edges of the scales in small spots and distributed irregularly; lateral line with a row of dark spots; a median lateral pale brown longitudinal band; all fins except ventrals with some dark color.

Length, $3\frac{15}{16}$ inches.

Described from No. 6273, Ichthyological Collections, Leland Stanford Junior University Museum, cotype, from Lake Biwa, near Matsubara, from collection of C. Ishikawa.

This species is only known to us from Lake Biwa, near Matsubara. With the exception of the two specimens before us and the type, we know of no other specimens.

(*Biwa*, the samisen, also the loquat tree, the name of the largest lake in Japan.)

7. PSEUDOGOBIO Bleeker.

Pseudogobio BLEEKER, Atlas Ichthyol., Cyprin., 1863, p. 29, (*esocinus*).

Body elongate, rather slender and tapering behind. Head elongate, pointed; snout long, concave above, and slightly produced, with its tip bluntly rounded; eye small, nearer posterior edge of opercle than

ip of snout; mouth small, protractile downwards, inferior, the maxllary not reaching nostrils; lips broad, fleshy, and covered with wellleveloped papillæ; a rather short, thick, maxillary barbel; teeth mall, 6 or 5, 2—2, 5 or 6; interorbital space broad and concave. ntestine short. Peritoneum silvery. Scales moderate, cycloid, about -2. Origin of dorsal nearer tip of snout than base of caudal; origin of anal far behind tip of depressed ventral; caudal emarginate; venrals inserted well behind origin of dorsal. Lateral line almost straight or very slightly decurved and continuous. Dorsal and caudal with listinct narrow blackish cross-bands.

Streams of Japan and Formosa.

(*ψεῦγς* false; *gobio*.)

13. PSEUDOGOBIO ESOCINUS (Schlegel).

KAMASUKA (SCYTHE FISH): KAWASAKI (RIVER-POINT).

Gobio esocinus Schlegel, Fauna Japonica, Poiss., 1846, p. 196, pl. xcix, fig. 2, near Nagasaki.

Pseudogobio esocinus Günther, Cat. Fish., VII, 1868, p. 175: from one of Schlegel's types.—Sauvage, Bull. Soc. Philom., Paris, 1883, p. 3 reprint; Lake Biwa.—Ishikawa, Prel. Cat., 1897, p. 15; Yeshigo, Tama, Chichibu, Suwa, Shinshin, Owari, Lake Biwa at Matsubara, Katsuwa R., Yamashiro, Kyoto, Kuruma.—Jordan and Snyder, Check List, 1901, p. 46; Lake Biwa.

Head $3\frac{3}{5}$; depth 6; D. II, 8; A. II, 7; P. 16; V. 8; scales 42 in the lateral line; 5 scales in an oblique series between origin of dorsal and lateral line, and 5 scales between the latter and middle of belly; pharyngeal teeth 6 or 5, 2—2, 5 or 6; width of head 2 in its length; snout 2 in head; eye 5; interorbital space $4\frac{1}{4}$; pectoral $1\frac{2}{5}$; ventral $1\frac{2}{3}$.

Body elongate, rather slender, tapering behind, and somewhat compressed. Head elongate, pointed, and compressed; snout long, compressed, concave above, and slightly produced beyond the mandible, the tip bluntly rounded; eye rather small, $2\frac{2}{3}$ in snout, high, and nearer the posterior edge of opercle than the tip of the snout; mouth small, protractile downwards, and inferior, the maxillary not reaching posteriorly as far as the nostrils; lips very broad and fleshy, and covered with well-developed papillæ, a rather short thick maxillary barbel equal to two-thirds the eye; pharyngeal teeth small, slender, compressed, hooked, and those in the lesser row very small and feeble; nostrils together and nearer the eye by two-thirds the length of the snout; interorbital space broad and concave, and the top of the head also concave. Gill-openings large and the membranes broadly united to the isthmus, forming a rather fleshy flap on each side below; gill rakers developed as numerous soft stumpy excrescences; gill-filaments long and very numerous. Intestine with a single convolution. Peritoneum silvery.

Scales large and cycloid, none on the breast; no pectoral flap; ventral flap present.

Origin of the dorsal nearer the tip of the snout than the base of the caudal by the length of the snout; the anterior developed dorsal rays extending beyond the tips of the last when the fin is depressed, and the upper edge of the fin straight or emarginate; origin of the anal about midway between the tip of the depressed dorsal and the base of the caudal, and the fin reaching two-thirds the distance to base of caudal; caudal deeply emarginate and the lobes pointed; pectoral broad, rounded, and reaching beyond the origin of the dorsal, and almost to the origin of the ventral; origin of ventral well behind the origin of the dorsal, and when depressed extending for half the space to origin of anal. Caudal peduncle rather short and compressed, its least depth about 4 in head. Lateral line nearly straight and continuous to the base of the caudal.

Color in alcohol dark brown above, pale or whitish below and washed with silvery; upper surface of the body speckled with darker brown spots, the sides with a series of about 12 large brownish spots along the lateral line; dorsal and caudal with 5 or 6 narrow blackish cross lines; pectoral with a few brown spots, the ventrals and anal pale; barbels and lips pale.

Length $7\frac{1}{16}$ inches.

This description from an example from Lake Biwa at Matsubara.

Of this species we have numerous specimens from Lake Biwa at Matsubara, the Kitakami River at Morioka, Matsushima, the Kinu River at Utsunomiya, the Chikugo River at Kurume, Tsuruga in Echizen, the Yodo River in Osaka, Kawatana in Hizen, the Iwai River at Ichinoseki, Kaminutani River in Omi, and an example from the collection from Karasaki, Lake Biwa, from K. Otaki.

It is one of the commonest of Japanese fishes, lying on the bottom among the rocks or weeds, in the fashion of the American species of *Hybopsis*.

(*esocinus*, pike-like.)

8. SARCOCHEILICHTHYS Bleeker.

Sarcocheilichthys BLEEKER, Cyprin. Prodr., 1860, p. 426 (*variegatus*).

Body elongate, oblong, and compressed. Head elongate, bluntly pointed, and compressed; snout blunt and obtusely rounded; eye small; mouth small, inferior; lips rather thick and fleshy; a very small and short maxillary barbel; teeth, 5—5; interorbital space, convex. Intestine short. Peritoneum silvery. Scales rather small, 42. Origin of dorsal nearer tip of snout than base of caudal; anal inserted below tip of depressed dorsal; caudal emarginate; ventrils inserted a little behind origin of dorsal. Lateral line almost straight and continuous. Breeding males with horny tubercles on snout and sides of head. Japanese species, resembling those of the American genus *Semotilus*.

(σάρξ, flesh; χεῖλος, lip; ἰχθύς, fish.)

14. SARCOCHEILICHTHYS VARIEGATUS (Schlegel).

HIGOI (SCARLET CARP), ABURAHAË (FAT MINNOW).

Leuciscus variegatus Schlegel, Fauna Japonica, Poiss., 1846, p. 213, pl. cii, fig. 2; Nagasaki.

Pseudogobio variegatus Günther, Cat. Fish., VII, 1868, p. 175; after notes of Bleeker on Schlegel's type.—Ishikawa, Zool. Mag. Tokyo, VII, August, 1895, p. 125; Otsu, Matsubara, and Maebara on Lake Biwa; Prel. Cat., 1897, p. 15; Lake Biwa, Maebara; Matsubara, Zensho, Tsuyama, Minasuka R., Kii.—Sauvage, Bull. Soc. Philom., 1883, p. 2, Lake Biwa.

Sarcocheilichthys variegatus Jordan and Snyder, Check List, 1901, p. 46; Lake Biwa.

Head $3\frac{2}{5}$; depth 4; D. III, 8; A. II, 7; P. 15; V. 8; scales 42 in the lateral line; 5 scales between origin of dorsal and lateral line, and 6 scales between the latter and middle of belly; pharyngeal teeth 5–5; width of head $1\frac{1}{5}$ in its length; snout $2\frac{3}{4}$ in head; eye $5\frac{1}{2}$; interorbital space $3\frac{1}{4}$; pectoral $1\frac{1}{3}$; ventral $1\frac{1}{2}$.

Body elongate, oblong, moderately deep and compressed. Head elongate, bluntly pointed and compressed; snout moderately long, compressed, very blunt, obtusely rounded and not protruding beyond the jaws; eye small, rather high, 2 in snout, and anterior in the head; mouth small, inferior and protractile, the maxillary reaching as far posteriorly as the posterior nostril; lips thick, rather broad and fleshy, and the lower broadly separated by the hard, rounded, horny symphysis; a very small and short maxillary barbel; pharyngeal teeth hardly hooked, and with broad grinding surfaces; nostrils rather large, close together, and much nearer the eye than tip of snout; interorbital space broad and convex, and the top of the head also convex. Gill-openings large, and the membranes broadly joined to the isthmus; gill-rakers few, short, and weak; pseudobranchiæ well developed. Intestine with a single convolution. Peritoneum silvery.

Scales large, cycloid, and imbricated along the sides; no pectoral flap; ventrals with a scaly flap at base.

Origin of the dorsal nearer the tip of snout than the base of the caudal by a space a little less than snout, the upper edge of the fin straight on, only very slightly concave, so that when depressed the tip of the first developed ray reaches posteriorly as far as the tip of the last; anal beginning much nearer the origin of ventrals than base of caudal, and the fin reaches more than half way to the latter; caudal forked and the lobes pointed; pectoral rounded and extending two-thirds the distance to base of ventral; ventrals entirely behind origin of dorsal, and extending posteriorly two-thirds the distance to anal. Caudal peduncle rather long, compressed, and its least depth 2[illegible] in head. Lateral line continuous and nearly straight along the sides.

Color in alcohol, dark brown above, below pale, or whitish washed with silvery, the sides more or less brassy; edges of most of the scales above and on the sides marked with brown; the sides along the lateral

line with a rather broad, brassy-brown longitudinal band, becoming most distinct along the caudal peduncle; a black spot behind edge of opercle; fins all more less tinged with brown, the dorsal with a trace of a dark cross bar. Male deep steel blue in life, a dark lateral shade interrupted on tail to form a caudal spot. Dorsal rosy tinted above. Caudal and anal bright yellow; pectoral and ventral with a scarlet area, head pink below.

Length, $7\frac{9}{16}$ inches.

This description from an adult male taken at Matsubara on Lake Biwa.

Fresh waters of southern Japan, very abundant, our many specimens from Matsubara on Lake Biwa, the Yodo River at Osaka in Settsu, the Chikugo River at Kurume in Chikugo, Lake Yogo near Nagoya, Funayado in Kiusiu, Tsuchiura, and Tokyo.

The young of this species differs in color from the adult, as the markings are much more distinct. The dorsal fin is pale, like the ventrals or anal, and is crossed by a jet black bar. The lateral band is also very distinct and generally results in a black blotch at the base of the caudal. As they grow older these markings become more indistinct. During the breeding season the snout of the male becomes covered with horny tubercles like those found in certain species of Hybopsis, Notropis, etc.

The following notes are given in a "Preliminary Note on the Fishes of Lake Biwa:"[a]

Young with yellowish ocher above, the dorsum bluish tinted; scales of sky-blue in front of dorsal; irregular sepia-brown markings, forming a straight line along lateral line, below which the ground color of the body fades away into a pale blue; sepia-brown blotches along the back; head with sepia-brown markings on upper jaw, interorbital space, and neck. Pupil, indigo-black, surrounded by sky-blue; fins yellowish ocher, the ends of dorsal, ventral, anal, and middle of caudal lighter; a row of elongated black streaks on upper third of dorsal between fin-rays.

Larger specimens brown above and on caudal; sides of head bluish, passing gradually to light crimson toward the ventral side; lips pale blue; pupil black with a crimson ring; dorsal third of body darker brown with traces of indigo; dorsal two-thirds of body covered with sepia-colored scales; dorsal, pectoral, ventral, and anal light brown with indigo on anterior parts of dorsal and ventral; ventrals and anal edged with light indigo; basal third of caudal with longitudinal streaks of brown.

Upper half of body deep indigo-blue, with scattered, darker-colored scales; below yellowish, quite light on ventrum, and with scattered golden yellow scales; ground color of head reddish yellow, the dorsal portion dirty green; eye deep indigo with crimson and indigo streaks around; dorsal and caudal greenish ocher; ventrals and anal white, with yellow stripes.

(*variegatus*, varied.)

[a] Zool. Mag., VII (Tokyo), Aug., 1895, pp. 125–127, by Dr. Ishikawa.

9. ABBOTTINA Jordan and Fowler.

Abbottina JORDAN and FOWLER, new genus (*psegma*).

Body elongate, oblong and compressed. Head elongate, pointed; snout elongate, compressed, concave above, and slightly produced, with the tip bluntly rounded; eye small, high, and midway in head; mouth small, inferior, protractile downward, and the maxillary not reaching eye; lips fleshy, not papillose; barbels moderate, one on each maxillary; teeth 5—5; interorbital space flat. Intestine short. Peritoneum silvery. Scales large, about 38, none on breast. Origin of dorsal nearer tip of snout than base of caudal, and inserted far behind base of last dorsal ray; caudal emarginate; ventral inserted a little behind the middle of the base of the dorsal.

Lateral line slightly decurved on the first 3 or 4 scales, after which it is straight and continuous. Dorsal and caudal with several dark, well-defined crossbars, as in *Pseudogobio*, which it resembles, but is easily distinguished by its smooth lips. Breeding males have the median dorsal rays enlarged, so that the fin is very large.

(Named for James Francis Abbott, late of Stanford University, since professor in the Japanese Military Academy at Etajima, who assisted Professors Jordan and Snyder in their work on Lake Biwa, Lake Yogo, Yodo River, and at Tsuruga and Misaki.)

15. ABBOTTINA PSEGMA Jordan and Fowler, new species.

Head, $3\frac{1}{2}$; depth, $4\frac{1}{3}$, D. II, 8; A. II, 8; P. I, 11; V. 8; scales 38 in the lateral line; 5 scales in an oblique series between the origin of the dorsal and about 6 between the latter and the middle of the belly; pharyngeal teeth 5—5; width of head $1\frac{4}{7}$ in its length; snout $2\frac{1}{4}$ in head; eye 5; interorbital space $3\frac{1}{3}$; pectoral a little shorter than the head; ventral $1\frac{1}{2}$.

Body elongate, oblong, moderately deep, and compressed. Head elongate, pointed, and compressed; snout elongate, compressed, concave above and slightly produced beyond the mandibles, the tip bluntly rounded; eye small, $2\frac{1}{3}$ in snout, high, and about midway in the length of the head; mouth small, inferior, and protractile downward, the maxillary reaching posteriorly beyond the nostrils, but not to the anterior margin of the eye; lips moderately broad, thick, and fleshy, but not covered with distinct papillæ, as they are perfectly smooth; barbel short, thick, and about equal to two-thirds the diameter of the eye; pharyngeal teeth small, weak, with a narrow grinding surface and slightly hooked; nostrils together, rather large, and nearer the eye than the tip of snout; interorbital space broad and flat, the top of the head also rather flat. Gill openings large, the gill membranes forming a rather fleshy flap on each side below; gill rakers short.

weak, fleshy, and in moderate number; gill filaments long; pseudobranchiæ well developed. Intestine with a single convolution. Peritoneum silvery.

Scales large and cycloid, none on the breast; no pectoral flap; ventral flap short.

Origin of the dorsal nearer the tip of the snout than the base of the caudal by the length of the snout, and the upper edge of the fin greatly convex on account of the great length of the median rays, so that when it is depressed it reaches posteriorly nearly to the base of the penultimate anal ray, and its length is equal to $2\frac{2}{5}$ in the body without caudal; origin of anal at about the last two-fifths of the space between origin of dorsal and base of caudal, and when depressed reaching about to the latter; caudal rather deeply emarginate, and the lobes pointed; pectoral long, the first rudimentary ray stout and strong, and the tip of the fin reaching beyond the origin of the dorsal,

FIG. 5.—ABBOTTINA PSEGMA.

but not quite to the base of ventral; ventrals inserted a little nearer origin of anal than that of pectoral, and reaching for two-thirds the space to the former. Caudal peduncle rather short and compressed, its least depth $2\frac{3}{5}$ in head. Lateral line slightly decurved on the first 3 or 4 scales, after which it is straight and continuous.

Color in alcohol, dark, rich brown above, below whitish and silvery, and the sides and upper surface specked and spotted with dark brown, very distinct on the latter; dorsal and caudal with narrow, blackish crossbars, the pectoral also with blackish spots above, and the ventrals and anal pale; axil of pectoral with a black spot; lips and barbels pale; length $4\frac{1}{8}$ inches.

Type No. 7721, Ichthyological Collections, Leland Stanford Junior University Museum. Locality, Yodo River at Osaka in Settsu. Cotype No. 50765, United States National Museum and Nos. 7721, 7148, Leland Stanford Junior University.

We have many specimens from the Yodo River at Osaka in Settsu, the Chikugo River at Kurume, and the Iwai River in Ichinoseki in Rikuchu.

In nonbreeding males, females, and young, the middle dorsal rays are not elongated, the upper edge of the fin being straight, and the sides are marked with rather large and distinct dark blotches.

(*ψέγμα*, dust.)

10. ZEZERA Jordan and Fowler.

Zezera JORDAN and FOWLER, new genus (*hilgendorfi*).

Body elongate, oblong, and compressed. Head rather small, depressed, and pointed, the upper and lower profiles straight; snout long; eye rather small; mouth small, terminal, oblique; upper lips rather broad; barbels 2; rather long, but shorter than eye; teeth small, 5—5; interorbital space broad and flattened. Intestine short. Peritoneum silvery. Scales small, cycloid, and not imbricated; 42 in the lateral line. Origin of dorsal midway between tip of snout and base of caudal; anal inserted behind tip of depressed dorsal; caudal emarginate; ventral inserted slightly before origin of dorsal. Caudal peduncle rather deep and compressed. Lateral line straight and continuous.

(*Zezera*, Japanese name of a small minnow, from *Zeze*, a village at the head of the Yodo River on Lake Biwa, remarkable for its very long bridge, one of the "seven wonders of Omi.")

16. ZEZERA HILGENDORFI (Ishikawa).

Sarcocheilichthys hilgendorfi ISHIKAWA, new species of Japanese fishes Ms. 1902.

Head $4\frac{1}{2}$; depth $3\frac{3}{4}$; D. III, 7; A. III, 6; P. 16; V. 8; scales 42 in the lateral line; 6 scales between origin of dorsal and lateral line, and 6 between latter and middle of belly; pharyngeal teeth 5—5; width of head $1\frac{1}{2}$ in its length; snout 3 in head; eye $4\frac{1}{4}$; interorbital space $2\frac{1}{4}$; pectoral $1\frac{3}{5}$; ventral $1\frac{1}{3}$.

Body elongate, oblong, and compressed. Head rather small, depressed, elongated, pointed, and the upper and lower profiles straight; snout long, pointed; eye rather small, anterior, and about $1\frac{2}{3}$ in snout; mouth small, terminal, very oblique, the mandible slightly produced in front, the maxillary protractile and not reaching the nostril; upper lips rather fleshy and dilated, the edge of the mandible more or less horny in the middle; maxillaries each with a barbel that is less than the eye; teeth small, weak, and hooked; nostrils close together on the sides of the snout and nearer the posterior extremity of the maxillary than the anterior margin of the eye; interorbital space broad and flattened, or only very slightly convex. Gill-opening rather restricted; gill-rakers small, few and weak; pseudobranchiæ present. Intestine short. Peritoneum silvery.

Scales moderate, cycloid, and not imbricated; no pectoral flap; ventral flap present.

Origin of the dorsal midway between tip of snout and base of caudal, the anterior rays the longest, and when depressed, the tip of the fin does not reach the origin of the anal; anal inserted a little nearer base of caudal than tip of pectoral, the fin short and reaching half way to base of caudal; caudal rather deep, emarginate; pectorals reaching about two-thirds the distance to origin of anal; ventral inserted slightly before the origin of the dorsal, or a little nearer the origin of the anal than that of the pectoral, and reaching two-thirds the distance to former.

Caudal peduncle deep and compressed, its least depth about $1\frac{3}{5}$ in the head. Lateral line straight and continuous.

Color, in alcohol, dark brown, tinted with dull olivaceous above, below pale or whitish; the lateral line is within a broad, deep brown, lateral band, which really begins on the snout, passing through the eye and backwards, even upon the middle caudal rays; lips pale; some of the scales on the lower portions of the sides tinted with pale brown; dorsal, caudal, and pectorals grayish, the other fins pale like the belly.

Length $4\frac{1}{8}$ inches.

We have but two examples of this species, the specimen described (No. 7722 L. S. Jr. Univ.) above from Funayado, in Kiusiu, the other in the U. S. National Museum, from the Kamo River, in Yamashiro, from the collection of the Imperial University. Dr. Ishikawa's specimens, the types of the species, came from the Ahasi River, in Mimisaku.

(Named for Dr. Franz Hilgendorf.)

11. BIWIA Jordan and Fowler.

Biwia JORDAN and FOWLER, new genus (*zezera*.).

Body elongate, compressed, rather thick, and somewhat broad forward. Head small, and below, together with the interorbital region, broad and flattened; snout bluntly rounded and produced; eye rather large; mouth small, inferior, the broad suborbitals overlapping on each side; no barbels; teeth, 5–5; interorbital space more or less flattened. Inside of gill-opening with a deep notch below. Intestine short. Peritoneum silvery. Scales large, imbricated, cycloid and about 33; no scales on the breast. Origin of dorsal midway between tip of snout and base of last anal ray, the radii 7; anal short, the radii 6, and its origin behind tip of depressed dorsal; caudal emarginate; ventrals inserted about opposite the middle of the base of dorsal. Lateral line straight after the first 3 or 4 scales, and continuous. This genus is close to *Pseudorasbora*, the latter differing principally in the deep notch inside the gill-opening below. *Biwia* differs also in the form of the mouth, which is small, inferior, and ensheathed on each side by the broad suborbitals.

(Named for Lake Biwa.)

17. BIWIA ZEZERA (Ishikawa).

ZEZERA.

Pseudogobio zezera ISHIKAWA, Zool. Mag., VII, 1895, p. 127, with plate; Lake Biwa at Otsu, Maebara and Matsubara; Prel. Cat., 1897, p. 16; same localities; also Zensho and Tsuyama River.

Head $4\frac{1}{3}$; depth $4\frac{2}{5}$; D. III, 7; A. III, 6; scales 33 in the lateral line; 4 scales between the origin of the dorsal and the lateral line, and 5 between the latter and the middle of the belly; pharyngeal teeth not examined, but probably 5—5; width of head $1\frac{1}{2}$ in its length; snout 4 in head; eye $3\frac{2}{3}$; interorbital space 3; pectoral a little less than head; ventral $1\frac{1}{4}$.

Body elongate, compressed, and somewhat broad forward. Head rather small, thick, and below, together with the inter pectoral region, broad and flattened; snout very bluntly rounded and produced; eye moderate, high, anterior, and a little longer than snout; mouth small, inferior, the broad suborbitals overlapping on each side; lips very thin; no barbels; nostrils large, close together, on each side of the snout, and the internasal space much less than the interorbital space; top of head and interorbital space flattened, the latter much broader than the eye. Gill-openings moderate, inside and below with a deep notch, gill-rakers very small and weak; pseudobranchiæ small. Intestine short. Peritoneum silvery.

Scales large, cycloid, of more or less even size, and those on the sides imbricated; no scales on breast; no pectoral flap; no ventral flap.

Origin of dorsal about midway between tip of snout and base of last anal ray; the anterior rays the highest; the base of the fin about $1\frac{1}{3}$ in the head; the length of the fin, when depressed, $3\frac{1}{3}$ in body without caudal, and the margin of the fin convex; anal beginning well behind tip of depressed dorsal, or about midway between the origin of the ventral and the base of caudal, the anterior rays the longest, the base of the fin short, and when depressed, the tip of the fin reaches two-thirds the distance to base of caudal; caudal emarginate; pectorals with the outer rudimentary ray enlarged and stiffened and reaching three-fourths of the distance to ventrals; ventrals inserted about opposite the middle of base of dorsal, or a little nearer the base of caudal than tip of snout, and reaching three-fourths of the distance to origin of anal. Caudal peduncle compressed, its least depth 2 in head. Lateral line almost straight, only slightly decurved upon the first three or four scales of its course.

Color in alcohol, brown, darker above, the lower surface pale or silvery; top of head and snout brownish; edge of each scale dark brown, so that a well-defined reticulated color pattern is present; fins all more or less grayish, the dorsal and caudal with some dark brown mottlings or blotches; a series of round dark blotches along the sides.

Length, $2\frac{7}{16}$ inches.

This description from an example from the Yodo River at Osaka, the only locality where the species was obtained by us. We do not hesitate to identify these specimens with Ishikawa's *Pseudogobio zezera*, as the characters in the main agree. However, he does not mention a notch inside the gill opening, a character also shared with *Pseudorasbora*.

The original description is as follows:

Head a little less than 5; depth 5; D. I, 8; A. I, 7; scales 38 in the lateral line, transversely 4½ above and 3½ below; pharyngeal teeth 5–5; eye 3½ in head; snout with the front end abruptly turned down, forming a rounded angle with the upper side; eye large; mouth inferior, horseshoe shaped, very small; barbels none; lower jaw with pendant, lateral lips; pharyngeal teeth arranged in two groups of 3 and 2. Origin of dorsal fin much nearer to end of snout than base of caudal. General color, shining, yellowish ocher, below silvery; a series of round, blackish blotches along lateral line; a similar blotch sometimes present on the occiput, and also along the dorsum; 3 to 4 series of small black spots on the dorsal and the ventrals. Otsu, Maebara, and Matsubara, Lake Biwa (Ishikawa).

12. PSEUDORASBORA Bleeker.

Pseudorasbora BLEEKER, Act. Soc. Indo-Neerl. Japan, VI, 1860, p. 97 (*parva*).

Body elongate. Head pointed, compressed; snout bluntly pointed; eye rather large; mouth terminal above, oblique, the mandible projecting, and the maxillary not reaching nostril; no barbels; teeth 5–5; interorbital space broad and flat. Inside of gill opening with a notch below. Intestine short. Peritoneum silvery. Scales large, cycloid, and about 38; breast scaled. Origin of dorsal nearer tip of snout than base of caudal; origin of anal begins below tip of depressed dorsal; caudal emarginate; ventrals inserted below origin of dorsal. Lateral line slightly decurved and continuous. Breeding males with the snout and sides of the head with horny tubercles.

Small fishes of Japan and China.

(ψεῦδης, false; rasbora, a related genus.)

18. PSEUDORASBORA PARVA (Schlegel).

MOROKO: HAYA.

Leuciscus parvus SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 215, pl. CII, fig. 3; streams about Nagasaki.

Pseudorasbora parva KNER, Novara Fische, 1867, p. 355, pl. XVI, fig. 2; Shanghai (called *Opsarus parvus* on plate).—GÜNTHER, Cat. Fish., VII, 1868, p. 186; Japan, Chi Kiang, China.—ISHIKAWA, Zool. Mag., VII, 1875, p. 128; Otsu, Maebara, Matsubara; Prel. Cat., 1897, p. 14; same localities, also Yodo River, Yoga Lake, Shima and Zensho.—JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1900, p. 344; Karasaki, Lake Biwa; Annot. Zool. Jap., III, 1901, p. 48; Lake Biwa.

Leuciscus pusillus SCHLEGEL, Fauna Japonica, Poiss., p. 216, pl. CII, fig. 4; near Nagasaki.

Head $4\frac{1}{3}$; depth 4; D. III, 7; A. II, 6; P. I, 13; V. 8; scales 38 in the lateral line; 5 scales between origin of dorsal and lateral line, and 5 between the latter and the middle of the belly; pharyngeal teeth 5—5; width of head $1\frac{3}{5}$ in its length; snout $3\frac{1}{2}$ in head; eye $3\frac{1}{4}$; interorbital space a little less than half the head; pectoral 1[illegible]; ventral $1\frac{1}{3}$.

Body elongate and compressed. Head pointed (compressed), the upper and the lower surface and the sides more or less flattened; snout bluntly pointed; eye rather large, anterior; mouth obliquely vertical and projecting in front the maxillary protractile, and not reaching front of nostril; no barbels; pharyngeal teeth rather small and hooked; nostrils close together in front of the eye above; interorbital space broad, nearly flat. Gill-openings moderate, lateral; gill-rakers merely fleshy rudiments; pseudobranchiæ developed. Intestine short and with few turns. Peritoneum silvery.

Scales rather large, of more or less even size, and cycloid; pectorals with a narrow, fleshy flap; ventral flap moderate, pointed.

Origin of dorsal anterior, nearer tip of snout than base of caudal, the anterior rays the highest, the base of the fin $1\frac{1}{2}$ in head, and the margin of the fin slightly convex; origin of anal much nearer tip of pectoral than base of caudal, small and similar to dorsal in shape; caudal emarginate, the lobes roundly pointed; pectorals reach about two-thirds the distance to ventrals; ventrals inserted below the origin of the dorsal and reaching two-thirds the distance to origin of anal. Caudal peduncle rather long; compressed, and a trifle more than the space between origins of pectoral and ventral. Lateral line almost straight, or only very slightly decurved, and continuous.

Color in alcohol, very dark grayish brown or black above, the sides and lower surface more or less silvery, each scale with a brown spot; sides with a pale, slaty gray lateral band, most distinct posteriorly; all the fins grayish brown or black, and more or less indistinctly spotted or speckled with darker.

In life the adult is golden yellow, the male with nuptial tubercles.

Length, $3\frac{7}{16}$ inches.

Here described from an example from Tsuchiura, near Tokyo. This very abundant minnow is represented in our collections by very many series of specimens from Tsuchiura, near Nagoya in Owari, Lake Yogo near Nakanogo in Mino, Lake Biwa at Matsubara, the Iwai River at Ichinoseki, the Chikugo River at Kurume, the Yodo River at Osaka, and several examples from the collection of K. Otaki, from Karasaki on Lake Biwa.

(*parvus*, small).

13. OTAKIA Jordan and Snyder.

Otakia JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1900, p. 345 (*rasborina*).

Body elongate; head elongate, eye large, anterior; mouth very oblique, lower jaw included, the maxillary protractile, and not reaching eye; no barbels; teeth 5, 2—2, 5, slender, hooked, and with a scarcely discernable grinding surface in two rows. Gill-rakers on first arch slender, pointed; pseudobranchiæ present. Air-bladder large, with a median constriction. Alimentary canal short. Peritoneum silvery. Dorsal inserted a little in advance of ventrals, of 8 developed rays, the anterior rays weak, and the edge of the fin concave; anal of similar shape, with 7 rays; caudal deeply notched, the tips pointed. Lateral line straight after the first 4 or 5 scales, where it is slightly decurved, and then continuous.

Color, light, with a silvery, lateral band.

Species of small size.

(Named for Keinosuke Otaki, a former student of the senior author; now professor in the Imperial Military Academy at Tokyo.)

19. OTAKIA RASBORINA Jordan and Snyder.

Otakia rasborina JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1900, p. 345, pl. IX, fig. 3; Lake Biwa.

Head 4; depth $4\frac{4}{5}$; D. 8; A. 7; scales 40 in a lateral series, 10 in a transverse series above ventral, and 17 between insertion of dorsal and occiput; eye 4 in head; snout $3\frac{1}{2}$; interorbital space $3\frac{1}{2}$; height of D. $5\frac{1}{5}$ in body; anal $7\frac{1}{2}$; caudal $3\frac{5}{6}$; pectoral 6; ventral $6\frac{2}{3}$.

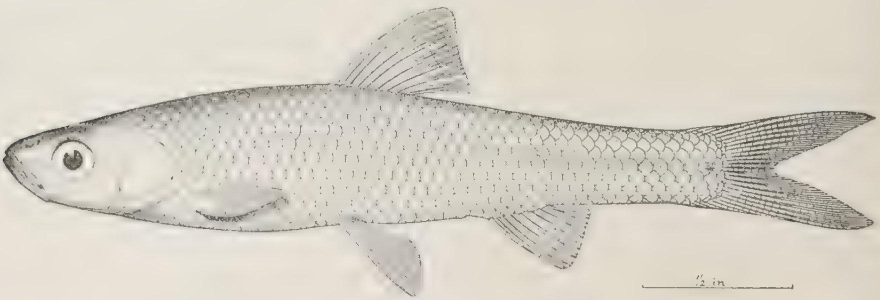


FIG. 6.—OTAKIA RASBORINA.

Body elongate, its depth about twice that of caudal peduncle. Head elongate; eye large, nearer tip of snout than posterior edge of opercle, a distance equal to half its diameter; mouth very oblique, the lower jaw included, the maxillary protractile, and not extending posteriorly to the edge of the orbit; no barbels, teeth slender, hooked and with a scarcely discernible grinding surface in two rows. Gill-rakers on first arch slender, long, pointed, and about 16 in number; pseudobranchiæ present. Air-bladder large, with a median constriction. Alimentary canal short. Peritoneum silvery.

Scales large.

Dorsal inserted a little anterior to the ventrals, the anterior rays weak; 8 developed rays, the first the longest and preceded by a shorter, slender, closely-adnate, simple ray, the other rays gradually shorter, and the edge of the fin concave, giving a somewhat falcate appearance when depressed; anal similar in shape to dorsal, the first developed ray preceded by a weaker, simpler, adnate ray, the second ray the longest and the others shorter; caudal deeply notched, the tips pointed; pectorals obtusely pointed; ventrals not reaching vent. Depth of caudal peduncle about 2 in depth of body. Lateral line extending along middle of body and caudal peduncle and straight, with the exception of a slight upper curve of the anterior 4 or 5 scales.

Color light; a silver lateral band, and a faint dark spot at base of caudal; a narrow, dark, medium dorsal band extending from head to base of caudal; upper parts with minute dots, especially upon the edges of the scales; dorsal fin a little dusky, the others without color.

Our specimen, probably young, 73 mm. (about 2¾ inches) long. Karasaki, Lake Biwa (Coll. K. Otaki) No. 49401 U.S.N.M.

The above description is from Jordan and Snyder. No specimens were taken by Jordan and Snyder in 1900.

(Name, a diminutive of Rasbora, a related genus. Rasbora is the Hindu name of *Rasbora rasbora.*)

14. TRIBOLODON Sauvage.

Tribolodon SAUVAGE, Bull. Soc, Philom. Paris, 1883, p. 16 (*punctatus*).

Barbels none; mouth small; suborbitals not dilated; pharyngeal teeth 5—2, recurved and hooked. Pseudobranchiæ present. Peritoneum sprinkled with black points. Scales small. Dorsal with at least 9 divided rays, short and opposite the ventrals; anal short. Scales small; lateral line decurved and low, but terminating at middle of caudal.

Of the group *Danionina.* (Sauvage.)

(*τριβόλα*, harrow; *ὀδούς*, tooth.)

20. TRIBOLODON PUNCTATUS Sauvage.

Tribolodon punctatum SAUVAGE, Bull. Soc. Philom. Paris, 1883, p. 6; Lake Biwa.

Head $5\frac{1}{3}$ in total; depth $6\frac{1}{2}$ in total; D. 9; A. 10; scales 75 in the lateral line. Body elongate; snout much longer than the eye, whose diameter is $3\frac{1}{2}$ in head; interorbital space very much larger than eye. Dorsal midway between tip of snout and origin of caudal and a little in advance of the ventrals; caudal emarginate. Top of head black; small black points upon the scales; a bluish band along the back; extremity of dorsal black; ventrals yellow. Length 95 mm. (about $3\frac{3}{4}$ inches). Lake Biwa (Sauvage).

This species was not taken by Jordan and Snyder.

(*punctatus*, spotted.)

15. LEUCISCUS Cuvier.

Leuciscus (Klein) CUVIER, Règne Animal, 1st ed. 1817, p. 194 (*dobula, rutilus, leuciscus, alburnus*, and *phoxinus*), *leuciscus*, the natural type.

Dobula RAFINESQUE, Ich. Oh., 1820, p. 45. (No type mentioned; *dobula* understood.)

Leuciscus RAFINESQUE, Ich. Oh., 1820, p. 45. (No type mentioned; *leuciscus* understood.)

Leuciscus AGASSIZ, Mém. Soc. Sci. Nat. Neufchâtel, 1835, p. 38 (*leuciscus*), (not *Leuciscus* Heckel, and of Günther, which is *Rutilus* of Rafinesque, the type being *rutilus*).

Squalius BONAPARTE, Fauna Italica, 1837, p. 6 (*tyberinus*).

Leuciscus BONAPARTE, Fauna Italica, 1837, p. 6 (*argenteus-leuciscus*).

Telestes BONAPARTE, Fauna Italica, 1837, p. 6 (*muticellus*).

Cephalus BONAPARTE, Catol. Metod., 1846, p. 39 (*cephalus;* no diagnosis).

Microlepis BONAPARTE, Catol. Metod., 1846, p. 39 (*turskyi;* no diagnosis).

Richardsonius GIRARD, Proc. Ac. Nat. Sci. Phila., 1856, p. 201 (*balteatus*).

Tigoma GIRARD, Proc. Ac. Nat. Sci. Phila., 1856, p. 205 (*pulchella*).

Cheonda GIRARD, Proc. Ac. Sci. Phila., 1856, p. 207 (*cooperi*).

Siboma GIRARD, Proc. Ac. Sci. Phila., 1856, p. 208 (*crassicauda*).

Clinostomus GIRARD, Proc. Ac. Sci. Phila., 1856, p. 211 (*elongatus*).

Protoporus COPE, Hayden's Geol. Surv. Montana for 1871, 1872, p. 473 (*domninus*).

Body oblong, compressed or robust. Head moderate; mouth usually large and terminal; lips normal; no barbels; teeth 5, 2—2, 4, usually 5, 2—2, 5 in the European types, hooked and with rather narrow grinding surface or none. Intestine short. Scales moderate or small. Dorsal posterior, usually behind ventrals; anal basis short or more or less elongate; caudal emarginate. Lateral line decurved, complete or variously imperfect. Size generally large, some species very small. A very large group, one of the largest current genera in ichthyology, represented by numerous species in the rivers of Europe, Asia, and North America.

The Japanese species belong to the typical subgenus, *Leuciscus*.

(λευκός, white.)

a Caudal peduncle not very stout, its least depth not two-thirds the head; scales not closely imbricated; dorsal usually inserted behind ventrals.
  b Scales large, 35 to 45.
    c Scales about 38 .... *japonicus*, 21.
    cc Scales 45 .... *cærulescens*, 22.
  bb Scales small, 60 to 100.
    d Scales 60 to 66.
      e Snout 3½ in head. Sides nearly plain silvery .... *phalacrocorax*, 23.
    dd Scales 70 to 78 .... *hakuensis*, 24.
    ddd Scales 80 to 95 .... *taczanowskii*, 25.
aa Caudal peduncle very deep and compressed, its least depth nearly equal to the depth of head. Dorsal inserted behind ventrals, much nearer base of caudal than tip of snout; scales loosely imbricated, 63 to 72; sides of body mottled with darker scales.
      f Snout 3⅗ in head: teeth 2, 5—4, 2 .... *jouyi*, 26.

21. LEUCISCUS JAPONICUS (Sauvage).

Squalius japonicus Sauvage, Bull. Soc. Philom., Paris., 1883, p. 4; Lake Biwa.

Head $4\frac{2}{3}$ in total; depth $5\frac{1}{2}$ in total, D. 9; A. 8; V. 8; scales 38 in the lateral line; pharyngeal teeth 5 – 3. Snout slightly more than eye, which is $3\frac{1}{2}$ in head; no pores on snout; suborbitals narrow; interorbital space flat, more than eye. Dorsal inserted nearer tip of snout than caudal peduncle, and somewhat behind ventrals; caudal emarginate. Lateral line straight. Color silvery; black points upon back and upon each scale of lateral line. Length 85 mm. (about $3\frac{5}{16}$ inches). Lake Biwa. (Sauvage.)

This species has been observed only in the collection sent from Lake Biwa to Dr. Sauvage by Dr. Steenacker. It was not seen by Jordan and Snyder.

22. LEUCISCUS CÆRULESCENS (Sauvage).

Squalius cærulescens Sauvage, Bull. Soc. Philom., Paris, 1883, p. 3; Lake Biwa.

Head $5\frac{1}{4}$ in total; depth $5\frac{1}{4}$ in total; D. 9; A. 8; scales 45 in the lateral line; pharyngeal teeth 5—2. Snout somewhat shorter than the eye, which is 4 in head; a few pores upon the snout; suborbitals narrow; interorbital space convex, and somewhat more than the diameter of the eye. Dorsal inserted somewhat nearer the extremity of snout than base of caudal, and somewhat behind the ventrals; caudal emarginate. Lateral line straight. Color silvery, clouded upon the back, and upon the top of the head; a bluish band along the lateral line. Length 120 mm. (about $4\frac{11}{16}$ inches). Lake Biwa. (Sauvage.)

This species is known only from the description of Dr. Sauvage. (*cærulescens*, bluish).

23. LEUCISCUS PHALACROCORAX Jordan and Fowler, new species.

Head $3\frac{5}{6}$; depth $4\frac{3}{4}$; D. III, 7; A. III, 8; P. 17; V. 9; scales about 62 in the lateral line; 12 scales between origin of dorsal and lateral line, and 12 between latter and middle of belly; pharyngeal teeth 2, 5—4, 3; width of head 2 in its length; snout $3\frac{1}{2}$ in head; eye $4\frac{1}{2}$; interorbital space 3; pectoral about $1\frac{1}{3}$; ventral $1\frac{2}{3}$.

Body elongate and compressed. Head elongate, pointed, compressed, the sides somewhat flattened, and the upper profile slightly convex; snout rather long; pointed and slightly convex and produced; eye small, anterior, and $1\frac{1}{3}$ in snout; mouth nearly horizontal, only slightly inclined, the maxillary protractile, and reaching posteriorly to the anterior margin of the eye; lips fleshy, not dilated; pharyngeal teeth with narrow grinding surface, scarcely hooked; nostrils close together on the snout above and nearer the eye than tip of snout; interorbital space and top of head convex. Gill openings large; gill-rakers short, and firm; pseudobranchiæ present. Intestine short. Peritoneum black.

Scales, cycloid, rather large, more or less even, and not imbricated; no pectoral flap; a small ventral flap.

Origin of dorsal midway between tip of snout and base of caudal; the first developed ray the highest, reaching beyond the others to the origin of the anal when depressed, the base of fin $1\frac{2}{3}$ in its height, and its upper edge nearly straight; origin of anal a little nearer tip of pectoral than base of caudal, the first developed ray the highest, reaching beyond the others when the fin is depressed, and its base $1\frac{1}{2}$ in its height, and its margin nearly straight; caudal deeply emarginate; pectoral reaching a trifle over two-thirds the distance to origin of ventral; ventral seven-ninths the distance to origin of anal. Caudal peduncle rather long, compressed, and its least depth $2\frac{1}{2}$ in head. Lateral line slightly decurved, and continuous.

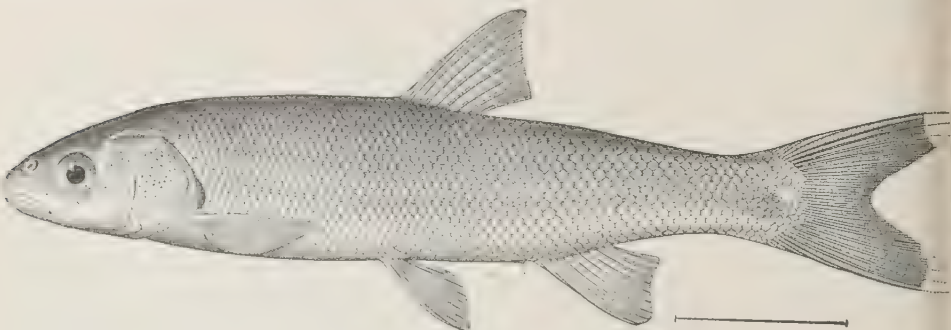


FIG. 7.—LEUCISCUS PHALACROCORAX.

Color in alcohol dark slaty brown, whitish or silvery beneath; dorsal and caudal brownish, pectorals also tinted with brown, all the other fins pale; a dark blotch along gill-opening above base of pectoral.

Length, $5\frac{3}{8}$ inches.

Type No. 7723, Ichthyological Collections, Leland Stanford Junior University Museum. Locality Tana River at Tachikawa.

Cotypes 50784, United States National Museum.

Of this species we have a number of specimens from the Tana River at Tachikawa, Koshyu (Imperial Museum), and the Kinu River in Utsunomiya. The specimens from the Tana River were obtained by us, through the efforts of trained cormorants, procured by Dr. Mitsukuri, Dr. Watase, and Dr. Iijima.

(*phalacrocorax*, "bald raven," the cormorant.)

24. LEUCISCUS HAKUENSIS Günther.

UGUI; AKAHARA (RED BELLY).

Leuciscus hakuensis GÜNTHER, Shore Fishes Challenger, 1880, p. 72, pl. XXXI, fig. B; Lake Hakone (misprinted "Hakow").—STEINDACHNER, Ichth. Beitr. 1881, p. 15; Japan.—JORDAN and SNYDER, Check List, 1901, p. 48; Yokohama.

Squalius hakuensis SAUVAGE, Bull. Soc. Philom., 1883, p. 4; Lake Biwa.

Leuciscus hakonensis ISHIKAWA, Zool. Mag., Tokyo, 1895, p. 129; Otsu on Lake Biwa.

Head $4\frac{1}{3}$; depth 4; D. III, 7; A. III, 7; P. 12; V. 8; scales 74 in lateral line; 14 scales between the origin of dorsal and lateral line, and 4 between the latter and middle of belly; pharyngeal teeth, 4, 2—2, 5; width of head about $1\frac{4}{5}$, or a little less than 2 in its length; snout $3\frac{1}{4}$ in head; eye $5\frac{1}{3}$; interorbital space 3; pectoral $1\frac{1}{2}$; ventral $1\frac{1}{2}$.

Body elongate and compressed. Head elongate, pointed, and compressed, the sides flattened, and the upper profile almost straight to tip of snout; snout rather pointed, somewhat broad and very slightly produced; eye small, anterior, $1\frac{1}{2}$ in snout; mouth moderate, the maxillary protractile, reaching posteriorly almost to the anterior margin of the eye, and not very oblique; lips fleshy, not dilated; pharyngeal teeth with grinding surface, not hooked; nostrils close together on the sides of the snout, and about half an eye diameter distant from the eye; interorbital space and the top of the head slightly convex. Gill-openings rather large; gill-rakers rather short and pointed, 4—9; pseudobranchiæ present. Intestine short. Peritoneum pale gray.

Scales cycloid, moderately small and of rather even size; no pectoral flap; ventral with a small fleshy flap.

Origin of dorsal midway between tip of snout and base of caudal, pointed, the first developed ray the highest, reaching beyond the others to origin of anal, when depressed, its base $1\frac{1}{3}$ in its height, and its upper edge nearly straight; anal inserted midway between tip of pectoral and base of caudal, the first developed ray the highest reaching beyond the others when the fin is depressed, the base of the fin is $1\frac{1}{3}$ in its height and its margin straight; caudal deeply emarginate, the lobes pointed.

Pectoral two-thirds the distance to ventrals; ventrals inserted a little nearer the origin of the anal than that of the pectoral, and a trifle over three-fifths the distance to the former. Caudal peduncle rather long, its least depth $2\frac{1}{4}$ in the head. Lateral line slightly decurved and continuous.

Color in alcohol dark brown, slightly olivaceous above and pale below; inside of gill-openings above dark; ventrals and anal pale or whitish; dorsal and caudal brown, the edges of the fin darker; pectoral grayish-brown.

Length, $13\frac{1}{4}$ inches.

This description from an adult female from Lake Jusan in Omori.

This is the most abundant species of *Cyprinidæ* in Japan, reaching a large size and often entering the sea. It ranges far to the northward, farther than any other of the *Cyprinidæ* except *Leuciscus taczanowskii*. Our many specimens are from Lake Jusan in Omori (collection Sotaro Saito), Kawajiri in Rikuchu (collection Mitonobu Irako), Kitakami R., Katase River near Enoshima, Matsushima Bay in Rikuzen, Same in Rikuoku (in salt water), Aomori in Rikuoku, Kitakami River in Morioka, Sendai, Niigata in Echigo, Iwai River in Ichinoseki, Tsuruga in Echizen, Kinu River at Utsonomiya, Hakodate,

Otaru, Lake Biwa at Karasaki, Noyshiro (collection K. Otaki), Hiroshima, a lake near Oide (collection Jouy), and Yokohama (collection Jouy). The species freely enters salt water.

(Name from Lake Hakone on the mountain between Izu and Sagami.)

25. LEUCISCUS TACZANOWSKII Steindachner.

KUKI.

Leuciscus taczanowskii Steindachner, Ichth. Beitr., X, 1881, p. 16; Sea of Japan. (Pectoral $1\frac{1}{2}$ in head, misprinted "$3\frac{1}{2}$.")

Head 4; depth $4\frac{2}{3}$; D. III, 7; A. III, 8; P. 17; V. 10; scales 93 in the lateral line (17 scales between the origin of dorsal and lateral line) and 14 between the latter and middle of belly; pharyngeal teeth 5, 2—2, 4; width of head $2\frac{1}{3}$ in its length; snout $3\frac{1}{3}$ in head; eye $5\frac{3}{4}$ in head; interorbital space a little over 3; pectoral $1\frac{1}{2}$; ventral 2.

Body elongate and compressed. Head elongate, pointed, compressed, and the sides flattened; upper profile of head almost straight to tip of snout; snout long, rather blunt and scarcely projecting beyond the mandible; eye small, anterior, $1\frac{3}{4}$ in snout; mouth moderate, the maxillary protractile, not reaching posteriorly as far as the eye, and not very oblique; lips fleshy, not dilated; pharyngeal teeth with grinding surface, slightly hooked; nostrils close together on the upper sides of the snout, and much nearer the anterior edge of eye than tip of the latter; interorbital space and top of the head rather broad and slightly convex. Gill-openings large; gill-rakers short, 4 + 10; pseudobranchiæ present. Intestine with a single convolution; peritoneum silvery.

Scales very small, cycloid, and of more or less even size; no pectoral flap; a small ventral flap.

Origin of dorsal nearer base of caudal than tip of snout, the first developed ray the highest reaching beyond the others to the origin of the anal when depressed, the base of the fin $1\frac{2}{3}$ in its height and its margin nearly straight; anal inserted midway between tip of pectoral and base of caudal, the first developed ray the highest reaching beyond the others when depressed, the base of the fin $1\frac{1}{4}$ in its height, and its margin nearly straight; caudal deeply emarginate, the lobes pointed. Pectoral reaches about two-thirds the distance to ventral; ventral inserted slightly before the origin of the dorsal, and reaches two-thirds the distance to anal. Caudal peduncle long, its least depth $2\frac{2}{3}$ in head. Lateral line slightly decurved, and continuous.

Color in alcohol dark brown, slightly olivaceous above, the lower surface of the body pale or whitish; dorsal, caudal, and pectorals grayish or brownish black, the other fins pale.

Length, $10\frac{3}{8}$ inches.

Fresh waters of Japan. We have a number of examples of this species from Lake Jusan, in Aomori, Noyshiro (collection, K. Otaki), and Junsaburogata (Nishitsu River), in Aomori (collection, S. Saito).

Its distribution is probably mainly northern.

(Named for Professor Taczanowsky, its discoverer.)

26. LEUCISCUS JOUYI Jordan and Snyder.

Leuciscus jouyi JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1901; Sasuna, island of Tsushima, Straits of Korea.

Head, 4; depth, $3\frac{3}{5}$; D. III, 7; A. III, 7; P., 16; V., 9; scales, 68 in the lateral line; about 18 scales between origin of dorsal and lateral line, and about 16 between the latter and middle of belly; pharyngeal teeth, 2, 5–4, 2; width of head, about $1\frac{3}{4}$ in its length; snout, $3\frac{1}{4}$ in head; eye, a little over 4; interorbital space, $2\frac{1}{2}$; pectoral, nearly $1\frac{1}{2}$; ventral, $1\frac{2}{3}$.

Body elongate, rather deep, and compressed. Head small, pointed, depressed, and its width equal to its depth; snout pointed, rounded, and slightly produced; eye moderate, anterior, about $1\frac{1}{4}$ in snout; mouth slightly oblique, the maxillary protractile, and reaching posteriorly to anterior edge of eye; lips somewhat fleshy, not dilated; several pharyngeal teeth of the outer row with narrow grinding surface, and others slightly curved; nostrils close together on sides of snout, nearer front of eye than tip of snout; interorbital space and top of head broad and slightly convex. Gill-openings large; gill-rakers short and pointed, 2+6; pseudobranchiæ present. Intestine short. Peritoneum silvery.

Scales large, cycloid, and of rather even size; no pectoral or ventral flap.

Origin of dorsal much nearer the base of the caudal than tip of snout, and when depressed it reaches within a short distance of the base of the last anal ray; origin of anal about midway between tip of pectoral and base of caudal; caudal broad and deep, emarginate and the lobes rounded; pectoral about three-fifths to ventral; ventral inserted well before the dorsal, and much nearer the tip of pectoral than origin of anal. Caudal peduncle very deep and compressed, the least depth about equal to the depth of the head. Lateral line slightly decurved and continuous.

Color in alcohol brown, a little darker above and somewhat paler beneath, the sides mottled with scales darker than the others.

Length, $5\frac{1}{16}$ inches.

This description from one of the cotypes, No. 6376, Ichthyological Collections Leland Stanford Junior University Museum. Locality, Sasuna, island of Tsushima.

Of this species we have a number of specimens from Sasuna, island of Tsushima (cotypes), and we refer to it others from Kaminutani River near Lake Biwa, province of Omi.

Most of our examples have a dark median band running along the back from the occiput to dorsal and then continued behind the fin to caudal. Some are also more or less finely mottled with brown and have pores about the head.

(Named for its discoverer, Pierre Louis Jouy.)

16. PHOXINUS (Rafinesque) Agassiz.

Phoxinus RAFINESQUE, Ich. Ohiensis, 1820, p. 15 (no species mentioned; *phoxinus* understood).
Phoxinus AGASSIZ, Mém. Soc. Sci. Nat. Neufchâtel, 1835, p. 37 (*phoxinus*).
Hemitremia COPE, Proc. Amer. Phil. Soc., 1870, p. 462 (*vittata*).
Iotichthys JORDAN and EVERMANN, Fish. N. M. Amer., I, 1898, p. 243 (*phlegethontis*).

This genus contains small, brightly colored minnows of America, Europe, and Asia, differing from *Leuciscus* only in the incomplete lateral line. The scales are usually small, and the fins of the breeding males bright red in the spring.

(*φοξός*, tapering).

27. PHOXINUS STEINDACHNERI Sauvage.

ABURAMUTSU (FAT CHUB).

Phoxinus steindachneri SAUVAGE, Bull. Soc. Philom., Paris, 1883, p. 5; Lake Biwa.

Head $5\frac{1}{3}$ in total; depth $6\frac{2}{3}$ in total; D. 9; A. 9; scales 80 in the lateral line. Snout longer than eye, which is $4\frac{1}{3}$ in head; interorbital space greater than eye. Dorsal beginning at an equal distance from caudal peduncle and center of eye; caudal emarginate, yellowish, with numerous clouded black points; a blackish band from eye to caudal; dorsal and caudal dark; top of head and tip of snout black.

Length 170 mm. (about $6\frac{11}{16}$ inches). Lake Biwa. (Sauvage.)

This species is known solely from the account given by Dr. Sauvage.

(Named for Dr. Franz Steindachner.)

17. ZACCO Jordan and Evermann.

Zacco JORDAN and EVERMANN, Fishes of Formosa, Proc. U. S. Nat. Mus., XXV, 1902, p. 322 (*platypus*).

Body moderately elongate and compressed; head compressed; snout conical, pointed; eyes moderate; mouth oblique, not notched; no barbels; teeth 5 or 4, 4, and 2 or 1 - 1, or 2, 4 and 4 or 5; interorbital space convex. Intestine short. Peritoneum black. Scales cycloid, narrowly imbricated, and 40 to 60 in the lateral line. Dorsal nearer tip of snout than base of caudal, or midway between, and its developed rays 7; anal inserted below, or a trifle before tip of depressed dorsal; its basis long, and composed of 9 or 10 developed rays; caudal emarginate; pectorals sometimes reaching ventrals; ventrals inserted a little before or below the origin of dorsal. Lateral line continuous and decurved. Breeding males have the head, the lower surface of the caudal peduncle, and the anal fin furnished with horny tubercles, not as numerous as those in *Opsariichthys*, and larger in proportion.

The anal fin also has the developed rays elongated and with adipose expansions.

(*Zako*, a Japanese name for river minnows, notably for *Acheilognathus lanceolata*.)

a Scales about 43; teeth in inner row 2—2; sides with broad, dark cross bars. *platypus*, 28.

aa Scales about 52, teeth in inner row mostly 1—1; a dark lateral band most distinct behind .... *temmincki*, 29.

aaa Scales about 60; a dark longitudinal stripe most distinct posteriorly.

b Maxillary not extending to opposite pupil, teeth 4, 4, 1—1, 4, 4..... *sieboldi*, 30.

28. ZACCO PLATYPUS (Schlegel).

HAE (MINNOW); OIKAWA.

Leuciscus platypus SCHLEGEL, Fauna Japonica, Poiss., 1840, p. 207, pl. CI, fig. 1; streams of Nagasaki.

Opsariichthys platypus GÜNTHER, Cat. Fish, VII, 1868, p. 296; Japan and Formosa.—SAUVAGE, Bull. Soc. Phil., 1883, p. 8; Lake Biwa.—ISHIKAWA, Zool. Mag., 1895, p. 121; Hikone, Matsubara on Lake Biwa; Prel. Cat., 1897, p. 11; Tega Lake in Shimosa, Fukiage, Tokyo, Chi R. in Musashi, Chichibu, Suwa Lake, Ise, Kishin, Lake Biwa, Zensho, Kyoto, Tsuyama R.

Barilius platypus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXII, 1900, p. 344, Lake Biwa; Coll. K. Otaki; Check List Fishes of Japan, III, 1901, p. 47; Lake Biwa.

Leuciscus macropus SCHLEGEL, Fauna Japanica, Poiss., p. 209, pl. CI, fig. 2; Nagasaki.

Leuciscus minor SCHLEGEL, Fauna Japanica, Poiss, p. 210, pl. CI, fig. 3; Nagasaki.

Head 4; depth $3\frac{1}{2}$; D. III, 7; A. III, 9; P. 13; V. 10; scales 43 in the lateral line; 8 scales between the origin of the dorsal and lateral line, and 5 scales between the latter and middle of belly; pharyngeal teeth 5, 4, 2—2, 4, 4; width of head $1\frac{3}{5}$ in length; snout a little over 3 in head; eye $4\frac{1}{2}$; interorbital space $2\frac{3}{4}$; pectoral 1; ventral $1\frac{1}{3}$.

Body elongate, compressed. Head moderate, compressed; snout slightly conical, pointed and not projecting; eye rather small, anterior and superior; mouth very oblique; the jaws rather thin and about equal; maxillary protractile, and not extending to the anterior margin of eye, but a trifle beyond the nostrils; no barbels; pharyngeal teeth without grinding surface, and slightly hooked; nostrils close together on the sides of the snout and nearer the eye than the tip of the former; interorbital space and top of head rather broad and convex. Gill-rakers short and pointed; pseudobranchiæ present. Intestine short and with few turns. Peritoneum black.

Scales rather large, and somewhat narrowly imbricated upon the sides; pectorals with a small, fleshy flap; ventrals with a small, scaly flap. Origin of the dorsal much nearer the tip of the snout than the base of caudal, when depressed reaching beyond the origin of anal, and the base of the fin a little more than half the head; anal inserted

a little nearer base of caudal than the origin of pectoral, and the base of the fin equal to three-fourths the length of the head; caudal deeply emarginate and the lobes sharply pointed; pectorals long, reaching the origin of the ventrals; ventrals inserted below the origin of the dorsal and reach to the origin of the anal. Caudal peduncle about as long as the ventrals, and its least depth about half their length. Lateral line strongly decurved and continuous to base of caudal.

Color in alcohol, dark bluish black above, the lower surface of the body silvery, and the sides with about 12 lead-blue cross-bands much broader than the spaces between; dorsal grayish with black streaks between each pair of rays and in the middle of the fin; caudal grayish, the other fins whitish with the anal tinged with grayish; sides of the head more or less grayish black. In life steel blue, the male with crimson fins.

Length, $5\frac{13}{16}$ inches.

This description from an adult breeding male taken at Tsuchiura, where we found it abundant and highly colored.

One of the most abundant of Japanese Cyprinidæ. It is represented in our collections by very numerous specimens from Tsuchiura, the Kinu River at Utsonomiya, the Yodo River at Osaka, the Chikugo River at Kurume, the Yabe River at Funayado; abundant in the clear water and very brilliant, Nagoya in Owari, Tana River at Tachikawa (caught by tame cormorants), Kawatana near Nagasaki, and Lake Biwa at Matsubara.

Breeding males are provided with numerous large and hard, horny tubercles. They have the anal fin enormously developed, so that it extends beyond the base of the caudal, and it is also sometimes furnished with tubercles like those found upon the head. The colors of these males are also much brighter than others in which the coloration is more silvery. Young specimens are silvery and with distinct grayish or pale brownish lateral bands posteriorly.

(πλατύς, broad; πούς, foot.)

29. ZACCO TEMMINCKII (Schlegel).

KAWAMUTSU (RIVER CHUB).

Leuciscus temminckii SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 210, pl. CI, fig., 4; Nagasaki.

Opsariichthys temminckii GÜNTHER, Cat. Fish, VII, 1868, p. 295, from one of Schlegel's types.—SAUVAGE, Bull. Soc. Philom, 1883, p. 5; Lake Biwa.—ISHIKAWA, Zool. Mag., 1895, p. 121; Hikone, Matsubara, Otsu; Zool. Mag., VII, 1895, p. 121; Hikone, Matsubara on Lake Biwa.

Barilius temmincki JORDAN and SNYDER, Check-list Fishes Japan, 1901, p. 47; Lake Biwa.—ISHIKAWA, Prel. Cat., 1897, p. 11; Ise, Zensho, Kishin, Matsubara on Lake Biwa.

Head $3\frac{4}{5}$; depth $3\frac{3}{4}$; D. III, 7; A. III, 10; P. I, 15; V. 9; scales 52 in the lateral line; 11 scales between the origin of the dorsal and the

lateral line, and 6 scales between the latter and the middle of the belly, pharyngeal teeth 5, 4, 1 – 1, 4, 4; width of head 2 in its length; snout 4 in head; eyes 4; interorbital space 3; pectoral $1\frac{1}{4}$; ventral $1\frac{3}{5}$.

Body moderately elongate and compressed. Head moderate and compressed; snout slightly conical, pointed and not projecting; eye moderate, anterior and superior; mouth oblique, the jaws moderately thick and about equal; maxillary protractile and reaching beyond the anterior margin of the orbit; no barbels; pharyngeal teeth without grinding surface and slightly hooked; nostrils close together on the sides of the snout and nearer the eye than the tip of the former; interorbital space and top of head rather broad and convex. Gill-rakers short and pointed; pseudobranchiæ present. Intestine with few turns. Peritoneum black.

Scales moderate and somewhat narrowly imbricated along the sides; pectorals with a small, fleshy flap; ventrals with a pointed, scaly flap.

Origin of dorsal midway between tip of snout and base of caudal; when depressed reaching slightly beyond the origin of the anal, and the base of the fin $2\frac{1}{4}$ in head; origin of anal inserted a little nearer tip of pectoral than base of caudal and its base 2 in head; caudal deeply emarginate and the lobes pointed; pectorals long and terminating near the origin of the ventrals; ventrals reaching for three-quarters the distance to origin of anal. Caudal peduncle $1\frac{1}{2}$ in head and its least depth $2\frac{3}{5}$ in head. Lateral line strongly decurved and continuous to base of caudal along lower.

Color in alcohol dark brown above, pale or silvery below; sides with a distinct deep brown, lateral band, broader and darker posteriorly; dorsal and caudal grayish, the former with dark streaks between the fin rays, and the other fins more or less pale.

Length, $4\frac{1}{4}$ inches.

This description from a male taken at Kawatana. This locality, together with the Mogi River, near Nagasaki, are the only places where the species was obtained by Jordan and Snyder. We have numerous specimens from Mogi.

This species is close to *Zacco sieboldi*, and is distinguished chiefly by its larger scales and having the maxillary reaching to or slightly beyond the anterior margin of the eye. Breeding males have horny tubercles on the sides of the head and about the snout.

(Named for Prof. C. J. Temminck of Leyden, the associate of Schlegel.)

30. ZACCO SIEBOLDI (Schlegel).

Leuciscus sieboldii Schlegel, Fauna Japonica, Poiss., 1846, p. 211, pl. ci, fig. 5; Nagasaki.

Opsariichthys sieboldii Günther, Cat. Fish., VII, 1868, p. 295 (copied).—Sauvage, Bull. Soc. Philom., 1883, p. 5; Lake Biwa.

Head 4; depth $3\frac{2}{3}$; D. III, 7; A. III, 10; P. I, 11; V. 9; scales 61 in the lateral line; 13 scales between the origin of the dorsal and the lateral line, and 5 between the latter and the middle of the belly; pharyngeal teeth 4, 4, 1 – 1, 4, 4; width of head $1\frac{3}{4}$ in its length; snout $3\frac{1}{4}$ in head; eye $4\frac{2}{3}$; interorbital space $2\frac{1}{2}$; pectoral $1\frac{1}{3}$; ventral $1\frac{3}{5}$.

Body moderately elongate and compressed. Head pointed and compressed; snout somewhat conical, pointed, but not projecting; eye rather small, anterior and superior; mouth very oblique, the jaws moderately thin and about equal, the maxillary protractile and reaching posteriorly almost to the anterior margin of the eye; no barbels; pharyngeal teeth without grinding surface and slightly hooked; nostrils close together, on the sides of the snout, and nearer the eye than the tip of former; interorbital space broad and very slightly convex. Gill-rakers short and pointed; pseudobranchiæ present. Intestine short and with few turns. Peritoneum black.

Scales small, cycloid and somewhat imbricated upon the sides; pectorals with a short, fleshy flap; ventrals with a small, scaly flap.

Origin of dorsal midway between tip of snout and base of caudal, when depressed reaching beyond the origin of the anal, and its base 2 in head; anal inserted a little nearer the tip of the pectoral than the base of caudal, and the base of the fin $1\frac{1}{2}$ in head; caudal deeply emarginate, the lobes pointed; pectorals moderate, reaching about two-thirds the distance to origin of ventrals; ventrals inserted before origin of dorsal, broad and bluntly rounded, and reaching three-fourths the space to origin of anal.

Caudal peduncle about equal to ventrals, and its least depth about two-thirds their length. Lateral line strongly decurved, continuous, and running along the lower part of caudal peduncle.

Color in alcohol, dark brown above, pale or whitish below; a distinct median, longitudinal, dark, brownish-black band, becoming broad posteriorly, and continuing to the base of the caudal; dorsal grayish with a blackish streak between each pair of rays, forming a broad band across the fin, the upper edge whitish; caudal grayish, the edges dark; anal pale, with grayish black markings between the rays; pectorals and ventrals pale, tinged with grayish.

Length, $5\frac{1}{4}$ inches.

This description from an adult breeding male from Lake Biwa at Matsubara.

Of this species we have many specimens from Lake Biwa at Matsubara, the Chikugo River at Kurume, near Nagoya in Owari, Kibami

in Omi (collection in Imperial Museum), Funayado in Kiusiu, and Karasaki on Lake Biwa (collection K. Otaki).

Breeding males, like those of *Zacco platypus*, have the sides of the head furnished with many large, horny tubercles, also the lower surface of the caudal peduncle and the anal fin. The rays of the anal are expanded and elongated. The color of the head is deep blackish-brown. Young specimens always have a blackish lateral band.

(Named for Philip Fredrik Siebold, of Leyden, who collected about Nagasaki and Omura, and under whose direction the Fauna Japonica was prepared.)

18. OPSARIICHTHYS Bleeker.

Opsariichthys BLEEKER, Atl. Ichthyol. Cyprin., 1860, p. 28 (*uncirostris*).

Body elongate, oblong, and compressed. Head rather pointed, greatly compressed, and the sides flattened; snout long; eye small, high; mouth large, very oblique, the maxillary reaching anterior margin of eye, and with a deep notch into which each ramus of the mandible fits; no barbels; teeth 5, 4, 2–2, 4, 5, on long, thin, pharyngeal bones; interorbital space broad and flat. Gill-rakers short, 3+9. Intestine short. Peritoneum silvery. Scales moderate, about 50, and more or less narrowly imbricated; a short pectoral flap. Origin of dorsal midway between tip of snout and base of caudal; anal basis long, with 9 developed rays, and its origin falling a little anterior to the tip of the depressed dorsal; caudal deeply emarginate; ventrals inserted below the origin of the dorsal. Lateral line continuous, and decurved. Breeding males have the head, lower surface of the caudal peduncle, and the anal fin furnished with numerous small horny tubercles. The anal fin has its rays elongate and more or less adipose.

Species of large size, inhabiting the Japanese lakes, especially delicate as food.

(ὀψαρίον, a little fish; ἰχθύς, fish.)

31. OPSARIICHTHYS UNCIROSTRIS (Schlegel.)

HASU.

Leuciscus uncirostris SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 211, pl. CII, fig. 2; near Nagasaki.

Opsariichthys uncirostris GÜNTHER, Cat. Fish., VII, 1868, p. 295 (copied).—SAUVAGE, Bull. Soc. Philom. 1883, p. 5; Lake Biwa—ISHIKAWA, Zool. Mag., VII, (Tokyo) 1895, p. 121, figs. 1, 2, 3; Lake Biwa in Omi—ISHIKAWA, Prel. Cat. 1897, p. 12; Nagahama and Matsubara on Lake Biwa—JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1900, p. 344; Lake Biwa; Coll. K. Otaki—JORDAN and SNYDER, Annot. Zool. Japan, III, (Tokyo) 1901, p. 47; Lake Biwa.

Head $3\frac{3}{5}$; depth $3\frac{3}{4}$; D. III, 7; A. III, 9; P. I, 16; V. 9; scales 50 in the lateral line; 10 scales between the origin of the dorsal and the lateral line, and 5 between the latter and the middle of belly;

pharyngeal teeth 5, 4, 2—2, 4, 5; width of head $2\frac{1}{6}$ in its length; snout $3\frac{1}{8}$ in head; eye 7; interorbital space $3\frac{1}{4}$; pectoral $1\frac{1}{4}$, ventral $1\frac{3}{4}$; eye 2 in snout.

Body elongate, oblong, and compressed. Head rather pointed, greatly compressed, the sides flattened, and the upper profile almost straight; sides of snout rounded, and the tip blunt and truncated; eye small, anterior and superior; mouth large, very oblique, maxillary reaching the anterior margin of the eye, protractile, ensheathed above, and with a deep notch along the sides, into which the rami of the mandible fit; lower jaw projecting, and the symphysis fitted into a notch in the upper jaw; pharyngeal teeth on thin and long bones, more or less conical, several in the larger row with narrow grinding surface, and all rather small; nostrils close together on the sides of the snout, and about a half an eye diameter distant from the upper front of the eye; interorbital space and top of the head broad and flattened, the former very slightly elevated. Gill-openings moderately large. Gill-rakers 3+9, short and firm; pseudobranchiæ present. Intestine with few turns, short. Peritoneum pale or silvery.

Scales large, cycloid, and more or less narrowly imbricated; a short, fleshy pectoral flap; ventrals with a scaly flap at base.

Origin of dorsal midway between tip of snout and base of caudal, when depressed, reaching beyond the origin of the anal, the base of the fin $2\frac{1}{3}$ in head, and its upper edge straight; origin of anal a little nearer the base of caudal than middle of pectoral, and the base of the fin $1\frac{2}{3}$ in head; caudal deeply emarginate, and the lobes pointed; pectorals long, reaching four-fifths the distance to origin of ventrals; origin of ventral below that of dorsal and reaching to within a short distance of the origin of the anal. Caudal peduncle $1\frac{3}{5}$ in head, and its least depth 3 in head. Lateral line continuous, inferior, and running along the lower part of the caudal peduncle.

Color in alcohol, dark brown above, the lower portions of the body pale; dorsal with the membranes between the rays and the tips of the posterior rays, grayish black, the rest of the fin paler; anal and caudal more or less grayish; pectorals and ventrals pale. Male with rosy shades in life.

Length, $12\frac{1}{2}$ inches.

This description from an adult male from Lake Biwa.

Of this species we have numerous specimens from Lake Biwa, at the little fishing hamlet of Matsubara, near Hikone, Lake Yogo, in Mino, the Yodo River at Osaka, and a few examples from the collection of K. Otaki, from Karasaki, on Lake Biwa.

This and numerous other species were collected also at Otsu, the chief town on Lake Biwa, by Prof. James F. Abbott.

Breeding males have the sides of the head, snout, mandible, lower surface of caudal peduncle, and anal fin provided with horny tubercles.

The anterior anal rays are elongate and extend to the base of the caudal.

The species, known locally as Hasu, reaches a larger size than any other Japanese minnow, except *Ishikauia steenackeri*. It is very delicate and finely flavored when boiled, and is much appreciated by Japanese epicures. It is also eaten raw.

(*uncus*, hook; *rostrum*, snout.)

19. ISCHIKAUIA Jordan and Snyder.

Ischikauia Jordan and Snyder, Proc. U. S. Nat. Mus., 1900, p. 346 (*steenackeri*).

Body elongate, compressed and deep. Head small, compressed, the upper profile nearly straight; snout and eye about equal, the latter about in the middle of the depth of the head; mouth very oblique, the maxillary protractile and reaching nostril; no barbel; teeth 5, 4, 2—2, 4, 5; interorbital space convex. Gill-rakers short and weak, about 4+9. Intestine short. Peritoneum silvery. Scales small, cycloid, about 70. Origin of dorsal midway between tip of snout and base of caudal; first developed ray of dorsal stiffened, spine-like; anal inserted behind tip of depressed dorsal, its base long, of 15 developed rays; caudal deeply emarginate, the lobes pointed; ventral inserted below origin of dorsal. Lateral line greatly decurved and concurrent with the lower profile of the body to the caudal.

Size large, color dusky.

This genus seems to be allied to the Chinese genus *Xenocypris*, differing in the smaller numbers of the teeth. (Named for Chiyomatsu Ishikawa, director of the Imperial Museum at Tokyo, who first sent us the species from Lake Biwa.)

32. ISCHIKAUIA STEENACKERI (Sauvage).

WADAKA; WATAKO (COTTON-THING); UMANO.

Opsariichthys steenackeri SAUVAGE, Bull. Soc. Philom. Poiss., 1883, p. 3; Lake Biwa.

Ischikauia steenackeri JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1900, p. 346, pl. x; Lake Biwa.

"Genus? species? Wadaka" ISHIKAWA, Zool. Mag., 1895, p. 129; Otsu, Hikone, Nagahama.

Head 5; depth $3\frac{5}{6}$; D. III, 7; A. III, 15; P. 17; V. 9; scales 70 in the lateral line; 12 scales between the origin of the dorsal and the lateral line, and 7 between the latter and the middle of the belly; pharyngeal teeth 5, 4, 2—2, 4, 5; width of head $1\frac{2}{3}$ in its length; snout 4 in head; eye 4; interorbital space $2\frac{3}{4}$; pectoral about $1\frac{1}{2}$; ventral $1\frac{1}{2}$.

Body elongate, compressed and deep. Head small, compressed, and the upper profile nearly straight; snout about equal to eye, bluntly pointed; eye large, anterior, and nearly in the middle of the depth of the head; mouth very oblique, the jaws nearly equal, the maxillary

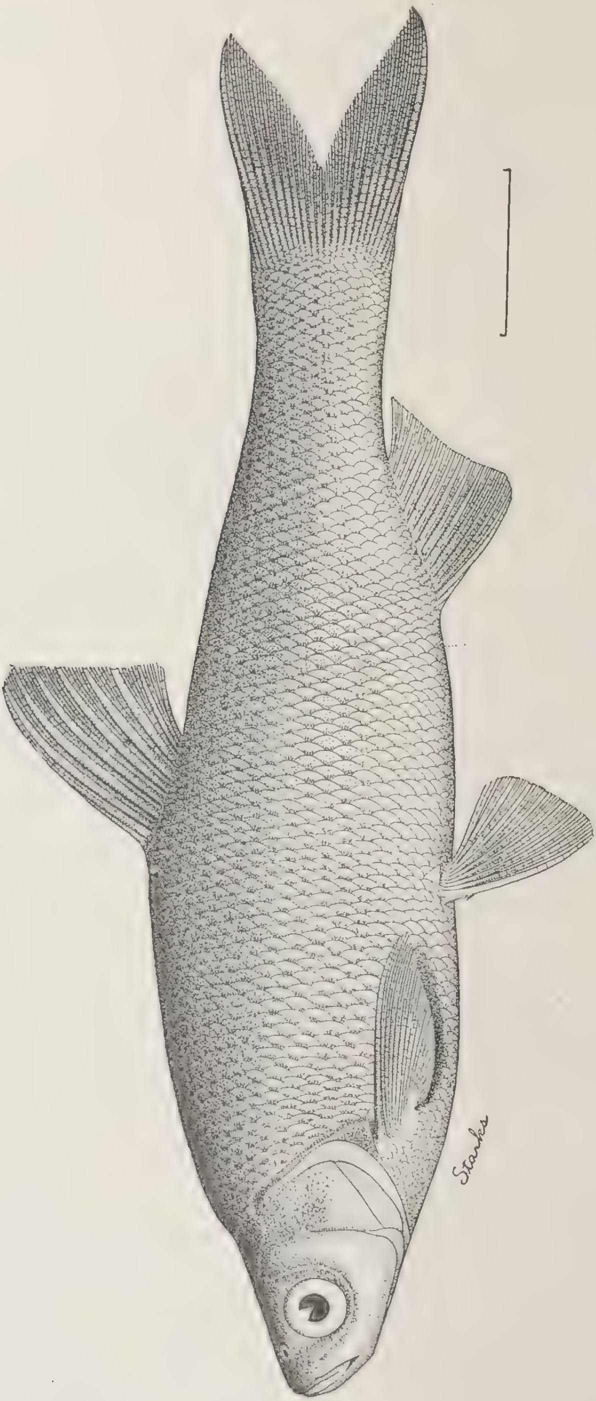


FIG. 8.—ISCHIKAUIA STEENACKERI.

protractile and reaching below the nostril; lips fleshy; pharyngeal teeth compressed, and those in the outer rows with a narrow grinding surface; nostrils close together on the sides of the snout and near the eye; interorbital space broad and convex. Opercles striated. Gill openings large; gill-rakers short, pointed, 4 + 9; pseudobranchiæ present. Intestine rather short; peritoneum gray.

Scales large, cycloid and of even size; a small pectoral flap; ventral flap present.

Origin of dorsal midway between the tip of snout and base of caudal; when depressed reaching almost to origin of anal, the base of the fin $1\frac{3}{4}$ in its height, and its upper margin straight; anal inserted nearer origin of ventral than base of caudal; the base of the fin long, about equal to the length of the ventral, and its edge straight; caudal deeply emarginate, and the lower lobe the longer; pectoral a little more than two-thirds to origin of ventral; ventral three-fifths to anal. Caudal peduncle deep, compressed, and its least depth 2 in head. Lateral line decurved, and concurrent with the lower profile of the body to the caudal.

Color in alcohol, dark brown above, below silvery or whitish; dorsal and caudal brownish; pectorals tinted with brown, the other fins pale; posterior edge of each scale upon the sides and upper surface with a dark spot.

Length, 12 inches.

Described from No. 6247 Ichthyological Collections, Leland Stanford Junior University Museum (collection K. Otaki).

Of this species we have many specimens from the collection of K. Otaki from Karasaki on Lake Biwa, Maebara on Lake Biwa, and the neighboring village of fisheries, called Matsubara; the Yodo River at Osaka, Noyshiro (collection K. Otaki), and Matsubara on Lake Biwa (collection C. Ishikawa).

This fish is known only from Lake Biwa and its outlet, Yodo River, being locally very abundant, and known commonly as Wadaka. It grows to a large size, and is sold in the markets of Maebara, Otsu, and Osaka, but it is little valued as food.

(Named for its discoverer, Francisque Steenacker.)

20. CARASSIUS Nilsson.

Carassius Nilsson, Prodromus, Ichthy. Scand., 1832 (*carassius*).

Body oblong, compressed and elevated. Mouth terminal, without barbels. Teeth 4—4, molar, but compressed. Scales large. Lateral line continuous. Dorsal fins very long, with the third ray developed into a stout spine, which is serrated behind; anal short with a similar spine. Ventrals well forward. Large species of the fresh waters of Europe and Asia; often domesticated.

(*carassius*, a Latinization of the vernacular names Karass or Karausche, applied to the European Crucian carp, *C. carassius*.)

33. CARASSIUS AURATUS (Linnæus).

FUNA, HIWARA, GENGOROBUNA (JOHNNY CARP).

Cyprinus auratus LINNÆUS, Syst. Nat., 10th ed., 1758, p. 323.
Carassius auratus GÜNTHER, Cat. Fish., VII, p. 32, and of all recent authors.

D. II, 18; A. II, 7; Scales, 26; teeth 4—4. Body stout, covered with large scales. Dorsal and anal fins with the spines strong, coarsely serrated. Coloration olivaceous, usually orange, or variegated in domestication.

Length, 12 inches.

Common everywhere in the streams of Japan and China. Our very numerous specimens of the common goldfish are from Chikugo River at Kurume, Tsuchiura, Same, Matsushima, Lake Biwa at Matsubara; Yodo River in Osaka, Wakanoura, Aomori, Nagasaki, Owari near Nagoya, Lake Yogo at Mino, Aomori, Migata, Morioka, Sendai, Tokyo, Kawatana, Tsuruga, and Tokyo. In its native condition the species is plain dark olivaceous.

(*auratus*, gilded.)

21. CYPRINUS (Artedi) Linnæus.

Cyprinus (Artedi) LINNÆUS, Syst. Nat., 10th ed., 1758, p. 320 (*carpio*).

Body robust, compressed. Mouth moderate, anterior, with 4 long barbels. Snout blunt, rounded. Teeth molar, broad and truncate, 1, 1, 3—3, 1, 1. Scales large. Lateral line continuous. Dorsal fin very long, with a stout spine, serrated behind; anal fin short, also with a spine. Large fishes of the fresh waters of Asia; introduced into Europe and America as food-fishes.

(*κυπρίνος*, the ancient name of the carp.)

34. CYPRINUS CARPIO Linnæus.

KOI.

Cyprinus carpio LINNÆUS, Syst. Nat., 10th ed., 1758, p. 320.—GÜNTHER, Cat., VII, p. 25, and of all authors.

Dorsal III, 20; A. III, 5; scales 5—38—5; teeth 1, 1, 3—3, 1, 1. Body stout, more or less compressd, heavy anteriorly. L. 18 inches or more. Fresh waters of central Asia; introduced as a food-fish into Europe and America. In domestication, it has run into many varieties, distinguished by differences in form, squamation, and development of fins.

The carp, or koi, is common throughout southern Japan, having doubtless been introduced from China, although much less common than the goldfish, or Funa.

(*carpio*, carp.)

SUMMARY.

Family Cyprinidæ.

1. *Pseudoperilampus* Bleeker.

1. *typus* Bleeker; Tsuruga, Tsuchiura, Matsushima, Tokyo.

2. *Paracheilognathus* Bleeker.

2. *rhombea* (Schlegel); Matsubara and Karasaki on Lake Biwa, Yodo River, Chikugo River, Funayado, Lake Yogo.

3. *Acheilognathus* Bleeker.

3. *limbata* (Schlegel); Lake Yogo, Iwai River at Ichinoseki, Nagoya, Kitakami River at Morioka.
4. *lanceolata* (Schlegel); Tsuchiura, Chikugo River, Yodo River, Lake Biwa at Matsubara and Katata, Lake Yogo, Funayado, Wakanoura, Nagoya.
5. *cyanostigma* Jordan and Fowler; Lake Biwa at Matsubara, Lake Yogo.

4. *Gnathopogon* Bleeker.

6. *elongatus* (Schlegel); Lake Biwa.
7. *gracilis* (Schlegel).

5. *Hemibarbus* Bleeker.

8. *barbus* (Schlegel); Yodo River, Lake Jensaburogata in Aomori, Chikugo River, Tokyo, Formosa.

6. *Leucogobio* Günther.

9. *güntheri* Ishikawa; Matsubara, Lake Biwa, Nagoya, Katata, Kurume.
10. *jordani* Ishikawa.
11. *mayedæ* (Jordan and Snyder); Karasaki, Zeze, and Matsubara on Lake Biwa, Yodo River, Nagoya.
12. *biwæ* (Jordan and Snyder); Matsubara on Lake Biwa.

7. *Pseudogobio* Bleeker.

13. *esocinus* (Schlegel); Karasaki and Matsubara on Lake Biwa, Kitakami River at Morioka, Matsushima, Kinu River, Tsuruga, Yodo River, Kawatana, Iwai River at Ichinoseki, Kaminutani River.

8. *Sarcocheilichthys* Bleeker.

14. *variegatus* (Schlegel); Matsubara on Lake Biwa, Yodo River, Chikugo River, Lake Yogo, Nagoya, Tsuchiura, Funayado, Tokyo.

9. *Abbottina* Jordan and Fowler.

15. *psegma* Jordan and Fowler; Yodo River, Osaka, Chikugo River, Iwai River.

10. *Zezera* Jordan and Fowler.

16. *hilgendorfi* (Ishikawa); river at Funayado in Kiusiu, Kamo River in Yamashiro.

11. *Biwia* Jordan and Fowler.

17. *zezera* (Ishikawa); Yodo River at Osaka.

12. *Pseudorasbora* Bleeker.

18. *parva* (Schlegel); Tsuchiura, Nagoya, Lake Yogo, Lake Biwa at Matsubara and Karasaki, Iwai River, Chikugo River, Yodo River.

13. *Otakia* Jordan and Snyder.

19. *rasborina* Jordan and Snyder; Karasaki on Lake Biwa.

14. *Tribolodon* Sauvage.

20. *punctatus* Sauvage.

15. *Leuciscus* Cuvier.

21. *japonicus* (Sauvage).
22. *cærulescens* (Sauvage).
23. *phalacrocorax* Jordan and Fowler; Tana River at Tachikawa, Koshyu, Kinu River at Utsonomiya.
24. *hakuensis* Günther; Lake Jusan, Kawajiri, Kitakami River near Morioka, Katase River near Enoshima, Matsushima, Same, Sendai, Niigata, Iwai River at Ichinoseki, Tsuruga, Kinu River at Utsonomiya, Hakodate, Otaru, Noyshiro, Hiroshima, Oide, Lake Biwa at Karasaki.
25. *taczanowskii* Steindachner; Lake Jusan in Aomori, Nishitzu River, Aomori, Noyshiro.
26. *jouyi* Jordan and Snyder; Sasuna, Tsushima, Kaminutani River.

16. *Phoxinus* (Rafinesque) Agassiz.

27. *steindachneri* Sauvage.

17. *Zacco* Jordan and Evermann.

28. *platypus* (Schlegel); Tsuchiura, Kinu River at Utsonomiya, Yodo River at Osaka, Chikugo River at Kurume, Yobe River at Funayado, Nagoya, Tana River at Tachikawa, Kawàtana, Lake Biwa at Matsubara
29. *temmincki* (Schlegel); Kawatana, Mogi.
30. *sieboldi* (Schlegel); Lake Biwa at Matsubara and Karasaki, Chikugo River at Kurume, Nagoya, Kitami, Funayado.

18. *Opsariichthys* Bleeker.

31. *uncirostris* (Schlegel); Lake Biwa at Matsubara and Karasaki, Lake Yogo, Yodo River.

19. *Ischikauia* Jordan and Snyder.

32. *steenackeri* (Sauvage); Lake Biwa at Maebara, Matsubara and Karasaki, Noyshiro, Yodo River at Osaka.

20. *Carassius* Nilsson.

33. *auratus* (Linnæus); everywhere in central and southern Japan.

21. *Cyprinus* Linnæus.

34. *carpio* (Linnæus); throughout southern and central Japan, probably introduced.

THE PHASMIDÆ, OR WALKINGSTICKS, OF THE UNITED STATES.

By Andrew Nelson Caudell,
Of the Department of Agriculture.

The Phasmidæ is one of the most interesting families of the order Orthoptera. It is poorly represented in the United States, and the species, being mimetic in nature, are not commonly met with. Our forms are all apterous and are confined in their distribution to the southern half of the country, with the exception of the species of the genus *Diapheromera*, one of which extends into Canada. The name "walkingstick" is commonly applied to these insects, and the common northern species, *Diapheromera femorata* Say, is the best known representative of the family. There is a popular belief extant in some parts of the country that these insects are very poisonous to stock when eaten by them. For this reason they have been called the "mule killer," though this name is more often applied to species of the family Mantidæ, which are said to be especially fatal to that useful animal. Among other popular names given to the walkingsticks are Devil's riding horse, Prairie alligator, Stick bug, Witch's horse, Devil's darning needle, Scorpion, and Musk mare, the latter applied only, I believe, to the species of the genus *Anisomorpha*.

Nowhere do we find more striking instances of protective resemblance than those afforded by members of this family of curious insects. In the tropics, where these insects abound, such amazing adaptations as the wonderful Walkingleaf, *Phyllium scythe*, and other large, winged forms are found. In the United States the species are all wingless and mimic different kinds of twigs, especially so the more slender species of the genera *Diapheromera*, *Bacunculus*, and *Parabacillus*.

The Phasmidæ are insects of very deliberate motion, especially the females. They do not depend upon locomotion for protection from their enemies, but to their deceptive resemblance and, in some cases, to the power of emitting an offensive spray from special glands situated on the prothorax.

The species are exclusively herbivorous, none being known to take animal food. One exception is recorded where some partially starved leaf insects nibbled at the foliaceous expansions of their fellows, but not enough to injure them in any way. The female of one of our species has been recorded as eating off the head of the male while under the influence of sexual excitement, but the insect in question was most surely not a Phasmid but a Mantid, as this habit is not at all uncommon among some members of that family.

Regeneration of limbs is quite common among the Phasmidæ. Such limbs are much smaller and may always be distinguished by the absence of one tarsal joint, all regenerated limbs being tetramerous. According to Scudder, if the leg be removed nearer to the body than the trochantero-femoral articulation the limb will not be replaced.

The eggs of our species are dropped at random on the ground. Oviposition takes place in the fall of the year with our common northern species and the eggs lie over winter, and sometimes even through a second, before the nymphs issue. When the young walkingstick is in the egg, ready to emerge, the meso- and metathorax are not remarkably elongate, but before the little creature is fairly out of its narrow prison the thoracic segments assume their usual proportions. It is said to be a most curious sight by those who have observed this almost instantaneous development.

In my studies of these insects specimens of all of our species have been examined, except *Diapheromera mesillana* and *carolina* and *Pseudosermyle stramineus*. The material of the U. S. National Museum forms the basis of this paper. Specimens were loaned for study by the Colorado and Oklahoma experiment stations. For various kindnesses I wish to express my sincere thanks to Professors Scudder and Bruner and Mr. J. A. G. Rehn.

The family Phasmidæ may be defined as follows:

Body elongate, subcylindrical; abdomen with ten segments, the basal one usually coalesced to the posterior part of the metathorax, sometimes entirely invisible;[a] all of the legs equally ambulatory; wings wholly absent in the United States species, the location of the metathoracic pair, and sometimes the mesothoracic pair also, generally indicated by a stationary wing-like pad, bearing a gland, presumably a scent gland; tarsi five jointed, except in *Timema*, terminated by two claws, between which is a large arolium; ovipositor concealed by the subgenital plate; cerci inarticulate.

[a] In descriptive work the first abdominal segment is spoken of as the intermediary segment and the abdomen is considered as consisting of nine segments. Thus the basal or first abdominal segment as used in the following pages is really the true second one. Likewise the seventh, eighth, and ninth segments are, respectively, the eighth, ninth, and tenth ones. The generally inconspicuous nature of the true basal segment, which is sometimes even wholly invisible, makes this nomenclature seem advisable.

The species occurring in the United States fall into four subfamilies, separated as follows.

a. Antennæ not more than one-half as long as the anterior femora.....CLITUMNINÆ.
aa. Antennæ distinctly longer than the anterior femora.
b. Mesothorax never less than four times as long as the prothorax, generally more; tibiæ not furnished at the apex beneath with a sunken areola..BACUNCULINÆ.
bb. Mesothorax never more than three times as long as the prothorax, generally less; tibiæ furnished at apex beneath with a sunken areola.
c. Coxæ visible from above; tarsi five jointed..................ANISOMORPHINÆ.
cc. Coxæ invisible from above; tarsi three jointed..................TIMEMINÆ.

Subfamily CLITUMNINÆ.

The insects representing this subfamily in the United States are very slender wingless walkingsticks with antennæ much shorter than the anterior femora in both sexes. The legs are slender and unarmed and the tibiæ are carinate beneath to the apex. The median segment is short and inconspicuous. Pronotum short as in *Bacunculinæ*. Cerci moderate, incurved in the male and straight in the female.

We have but one genus, which is here characterized as new.

PARABACILLUS, new genus.

Bacillus SCUDDER (not Latreille), Psyche, VI, 1893, p. 372.

Antennæ less than one-half as long as the anterior femora, composed of six or seven segments in the male and probably about that number in the female, but there, as also sometimes in the male, the segments are so closely connate as to be inseparable, except the first and second, which are very distinct.[a] Head subpyriform, horizontal. Eyes small, round. Thorax with the pronotum about one-fifth as long as the mesonotum. Legs, smooth, unarmed, long and slender. Cerci as in *Diapheromera*.

Dr. Scudder considered the species of this genus to belong to the subfamily Bacillinæ and placed them in the old world genus *Bacillus*. But the absence of an areola at the apex of the tibiæ below refers them to the subfamily Clitumninæ. In many particulars the genus seems closely allied to the genus *Paraclitumnus* of Brunner von Wattenwyl. We have a single species of the genus.

PARABACILLUS COLORADUS Scudder.

Plate LVII, fig. 1; Plate LVIII, fig. 1.

Bacillus coloradus SCUDDER, Psyche, VI, 1893, p. 372; Proc. Davenp. Acad. Sci., IX, 1902, p. 21, pl. I, fig. 4.
Bacillus carinatus SCUDDER, Psyche, VI, 1893, p. 372.

[a] *Bacillus hispanicus* Bolivar, belongs to this genus, but the antennæ are composed of sixteen distinct segments. The *Bacillus palmeri* of the author, recently described from Mexico, is also a member of this genus.

The following description is that of the author,[a] which is quoted in full:

Bacillus coloradus Scudder (pl. 1, fig. 4), Baker's ranch, Beulah, Sapello Canyon, 8000′ on *Monarda stricta* (Willmatte P. Cockerell); La Trementina (Alice Blake). The following description was taken from the first specimen, which is that figured:

Testaceous, more or less clouded with fuscous dorsally. Head striped feebly with fuscous, especially above and with five subequidistant delicate longitudinal carinæ; whole thorax and abdomen similarly carinate, but otherwise smooth except for very minute rather sparsely scattered ferruginous granules between the dorsal and subdorsal carinæ; second joint of antennæ small and globular, the remainder consisting of a hardly articulate, slightly depressed, lanceolate, bluntly pointed mass.

Length of body, 48 mm.; antennæ, 4.5 mm.; mesothorax, 10.5 mm.; metathorax, 8.5 mm.; abdomen, 25 mm.; hind femora, 12 mm.; width of metathorax in middle, 1.5 mm.

The above description is from a female specimen. The males are more slender, with longer antennæ and legs.

From a study of a series of specimens, both male and female, from Nebraska, Colorado, New Mexico, Arizona, and California I conclude that there is but one species. They show a certain amount of variation in color and size, but afford no specific characters. The antennæ of a mature pair from California measure 5 mm. in the female and 7 mm. in the male. One male from Arizona has antennæ measuring 12 mm. in length. The color varies from almost wholly infuscated to a light brown. One female from California has an extreme length of very nearly 70 mm. But there are all stages of gradation between these extremes of color and size and no characters present themselves to warrant the recognition of more than the one species.

Subfamily BACUNCULINÆ.

The members of this subfamily are long, slender, stick-like insects with the mesothorax at least five times as long as the prothorax; antennæ, except in *Sermyle*, more than twice as long as the anterior femora; tibiæ without a sunken areola at apex beneath.

The slender body at once distinguishes this subfamily from the others of our fauna except Clitumninæ. The long antennæ, however, readily separates it from that group. We have four genera of Bacunculinæ occurring in the United States. The following table will serve to separate them:

a. Head subquadrate or subcylindrical, usually distinctly longer than broad, attached obliquely or horizontally. (Plate LVII, fig. 4.) Male cerci subequal throughout or apically trifid.

b. Middle femora of the male not much swollen, not thicker than the posterior ones; posterior femora unarmed in both sexes.

c. Male cerci apically trifid; head carinate or longitudinally rugose between the eyes; antennæ rarely twice as long as the anterior femora.
Pseudosermyle, new genus.

cc. Male cerci simple; head smooth; antennæ more than twice as long as the anterior femora .... *Bacunculus* Burmeister.

[a] Proc. Davenp. Acad. Sci., XIV, 1902, p. 21.

bb. Middle femora of the male much swollen, distinctly thicker than the posterior ones; posterior femora armed beneath on the median line near the apex with a single spine, in the male very prominent, in the female often very small and sometimes wholly absent .... *Diapheromera* Gray.

aa. Head ovate, short, scarcely longer than broad, attached vertically (Plate LVII, fig. 2*a*); male cerci spatulate, much broader apically than at the base (Plate LVII, fig. 2*b*).......... *Megaphasma*, new genus.

PSEUDOSERMYLE, new genus.

Head subcylindrical, distinctly longer than broad, horizontally attached to the thorax and in front between and behind the eyes either carinate or longitudinally rugose; antennæ no more, or but little more, than twice as long as the anterior femora; legs unarmed; basal segment of the abdomen generally subquadrate in the female, twice or more than twice as long in the male. Cerci of the female simple, of the male apically trifid.

This genus, of which *P. banksii* may be considered the type, is most nearly allied to *Sermyle* Stål, but differs in the character of the male cerci, which are simple in the latter genus.[a] The head of the only species of *Sermyle* examined, a female from Guatemala, is very much shorter in proportion than found in the species of *Pseudosermyle*. It is also somewhat closely allied to *Bacunculus*, and the most stable character for its separation from that genus, exclusive of the male genital characters, seems to be the dorsally carinate or rugose head.

The males of *Pseudosermyle strigata* and *arbuscula* are unknown and it may be that these species will eventually prove to belong to *Sermyle*, but until the male sex is made known it is deemed safest to include them here.

Pseudosermyle is represented in the United States by five species, which may be separated by the following tables. The first table is based wholly upon the characters of the female:

a. Body multicarinate or longitudinally rugose.
- *b.* Cerci short, no more than three times as long as the greatest width; supraanal plate subtruncate or obtusangulate at the apex.
  - *c.* Femora short and stout (Plate LVIII, fig. 4), the posterior ones about nine mm. in length .... *arbuscula* Rehn.
  - *cc.* Femora longer and more slender (Plate LVIII, fig. 3*a*), the posterior ones about twenty mm. in length .... *truncata*, new species.
- *bb.* Cerci long, six times as long as the greatest width; supraanal plate acutely angulate at the apex .... *strigata* Scudder.

aa. Body smooth .... *stramineus* Scudder.

Pseudosermyle banksii does not appear in the above table for the reason that the female is unknown. The species of which the males

[a] The male of *Sermyle mexicanus* Saussure, the type of *Sermyle*, is not positively known, but a male specimen that Stål thought quite surely belonged to that genus had simple cerci, as in *Bacunculus*. Besides this, other Mexican species referred to this genus have simple cerci.

are known may be separated by the following table, which is based wholly upon the characters of that sex:

a. Seventh abdominal segment distinctly inflated on the posterior half.
b. Long and slender, length about 60 mm . . . . *banksii*, new species.
bb. Shorter and less slender, length about 40 mm . . . . *truncata*, new species.
aa. Seventh abdominal segment not inflated . . . . *stramineus* Scudder.

PSEUDOSERMYLE ARBUSCULA Rehn.

Sermyle arbuscula Rehn, Can. Ent., XXXIV, 1902, p. 273.

The following description of this species is taken in full from the author's article referred to above:

Type, female, San Diego, California, May 7, 1901.

This species does not seem to be very closely related to any of the previously known species of the genus. From *azteca* Saussure, it is differentiated by having the femora carinate and striate; from *saussurii* Stål, by the nonampliate sixth abdominal segment; and from *strigata* Scudder, by the more robust limbs and the less strongly striate body. With *mexicana* and *linearis* Saussure, no affinity exists.

General form slender, the thoracic portion rather robust. Head rather elongate, bearing two central longitudinal rugæ, which become obscure caudad, the whole surface of the head rather tuberculate, the tubercles being longitudinally disposed; eyes subspherical, slightly exerted; antennæ longer than cephalic femora; the proximal segment large and broad, with the distal section contracted, this segment over twice as large in bulk as the next. Pronotum, mesonotum, and metanotum tuberculate, the tubercles resolving into longitudinal series, this being more apparent on the metanotum, the mesonotum and metanotum being centrally carinate; pronotum rather narrow, not quite equaling the head in length; mesonotum long (with pronotum equaling the cephalic femora), the lateral margins slightly tuberculate; metanotum very considerable shorter than the mesonotum, comparatively robust, expanding in the caudal portion. Abdomen rather slender, multistrigate, none of the segments exhibiting any special ampliation; ventral surface between the sixth and seventh segments exhibiting a pair of flattened longitudinal processes. Cephalic femora heavy, with the proximal diastema (found in many representatives of this family) rather well marked, the remaining section of the segment being inflated and with three prominent angles; tibiæ as long as the femora, quadrate slightly tapering; first tarsal joint about as long as the succeeding ones. Intermediate femora short, triangular in section, equaling the metanotum (and median segment) in length; tibiæ depressed, about equaling the femora in length; first tarsal joint considerably less than the succeeding joints in length. Caudal femora short, reaching the middle of the third abdominal segment, roughly triangular in section; tibiæ rather longer, reaching to the apex of the first segment. General color, reddish brown, washed with ashy gray on the cephalic limbs.

Measurements.

	mm.
Length of body	54
Length of pronotum	3
Length of mesonotum	12
Length of metanotum (with median segment)	8.7
Length of abdomen	28
Length of cephalic femora	14
Length of intermediate femora	7.5
Length of caudal femora	8.7

The supranaal plate of this species is shown at Plate LVII, fig. 3, and for this drawing I am indebted to the describer. This species seems remarkable for the extreme brevity of the posterior femora.

PSEUDOSERMYLE TRUNCATA, new species.

Plate LVIII, figs. 3, 3*a*, 3*b*.

Color grayish brown. Head above with two pairs of prominent carinæ, the carinæ of each pair subparallel at base, flaring somewhat just beyond the middle and then rapidly converging slightly beyond the eyes by the incurving of the outer carina. Just anterior of the termination of these carinæ is an elevated, posteriorly bifurcated tubercle and between the two pairs of carinæ is a minute mesial carina extending halfway along the length of the head. Antennæ basally thicker than in *strigata*. Pronotum above with a slight mesial longitudinal incision and with a shallow transverse furrow just behind the middle which does not extend to the borders, which are strongly carinate; disk with two subdorsal carinæ, less distinct behind the transverse furrow, and with a couple of indistinct, less elevated carinæ between them and the border of the pronotum; mesonotum, and metanotum, together with the intermediary segment and the abdomen carinated as in *strigata*, but the whole body is much less covered with tubercles, the abdomen being almost entirely destitute of them and the thorax supplied more sparingly than in that species. Legs much more robust than in *strigata* and showing traces of fuscous bands more noticeable on the middle femora. Supraanal plate broader than in *strigata* and subtruncate apically. Cerci short and comparatively broad, about three times as long as broad.

Length of body, 73 mm.; mesothorax, 16.5 mm.; metathorax, 10.5 mm.; middle femora, 15 mm.; hind femora, 20 mm.

One female, Dos Cabezos, Arizona, June, 1891.

Type.—No. 6613, U.S.N.M.

One immature female specimen, in poor condition, from Bright Angel, Arizona, is referred to this species. It has the posterior femora extending only to the middle of the fourth abdominal segment and the basal five segments of the abdomen are furnished posteriorly above with two prominently elevated tubercles, one on each side.

The U. S. National Museum also contains one female and six male specimens from Los Angeles County, California, that evidently belong here. The female is apparently immature, probably being in the last stage. It is 54 mm. long, and the posterior femora are 16 mm. in length. The males differ from the females in being entirely smooth except for the two main carinæ on the anterior part of the head between the eyes, and in being smaller and quite slender. The cerci project obliquely downward, are trifid apically, the center branch forming the terminus of the main body of the cerci, and engage each

other at their tips. Plate LVIII, fig. 3, represents the cerci of the male of this species. In immature specimens the cerci are simple, being merely flattened and slightly concave.

The measurements of these male specimens are as follows: Length of body, 40 mm.; antennæ, 27 mm.; mesothorax, 9.5 mm.; metathorax, including the intermediary segment, 7.5 mm.; fore femora, 13.5 mm.; middle femora, 12 mm.; hind femora, 15 mm.; width of middle of mesothorax, 1.5 mm.

These Californian specimens are much lighter colored than those from Arizona, and may represent a new species, but without additional material it is not deemed advisable to describe them as such.

The type specimen was received at the Department of Agriculture on June 17, 1891. The following note regarding it is quoted from the notebook of the Division of Entomology:

Rec. from F. W. Anderson, Asst. Ed. Am. Agr., N. Y., 1 specimen, female, of a *Diapheromera*, new to the collection, received from Los Cabezos, Arizona, with the statement that it is more deadly to stock than loco-weed if eaten by them. It is called in that section "Campo mucho."

This species, while in general resembling *strigata*, is really very distinct. The broader supraanal plate with its subtruncate apex, short broad cerci, larger legs and smoother body, will at once distinguish it from that species.

PSEUDOSERMYLE STRIGATA Scudder.

Plate LVI, fig. 3; Plate LVIII, fig. 8.

Sermyle strigata Scudder, Cat. Orth. U. S., 1900, pp. 14, 94–95, pl. I, fig. 3.

The author's description is as follows:

Whole body dull ashy gray. Head furnished above with four longitudinal rows of small tubercles. Whole thorax mesially carinate and also furnished above on either side with a pair of carina, all the carinæ equidistant and furnished, as well as the intermediate spaces, with small sparsely scattered tubercles. Abdomen and intermediary segment similarly marked, but with an additional pair of subdorsal carinæ and with fewer and much more obscure granulations, mostly confined to the carinæ. Hind femora reaching to the end of the fifth abdominal segment. Abdomen nowhere expanded.

Length of body, 72 mm.; antennæ, 30 mm.; mesothorax, 18.5 mm.; metathorax, 10.5 mm.; abdomen, 35.5 mm.; hind femora, 22.5 mm.; width of middle of mesothorax, 3 mm.

Three males. Texas, Boll, Lincecum.

This species appears to fall near *S. azteca* Sauss., but differs by the carinate thorax with its dull coloring.

The cerci, as shown in the table of species, are very long, being six times longer than broad.

PSEUDOSERMYLE STRAMINEUS Scudder.

Plate LVIII, fig. 2.

Bacunculus stramineus SCUDDER, Proc. Davenp. Acad. Sc., IX, 1902, p. 20, pl. ., fig. 1.

Described by the author as follows:

Bacunculus stramineus Scudder, sp. nov. (pl. I, fig. 1). Body very slender, flavo-testaceous, the sides of the thorax, the undersurface of the metathorax, and most of the undersurface of the middle femora white or hoary, at least in the male, the tibiæ more or less tinged with green in the female; the terminal abdominal segments are more or less hoary (male) or green (female). Head a little longer than the pronotum, somewhat tumid in the female, laterally striped with white in the male, in the latter with a pair of longitudinal rugæ following behind the inner margin of the antennal scrobes; antennæ pale green (female) or testaceous, becoming apically infuscated (male), very slender and shorter than the body. Body smooth, the thorax with a feeble median carina. Seventh abdominal segment of male nearly as long as the eighth and ninth together, the ninth slightly longer than the eighth, the seventh segment not inflated, bearing beneath a bulbous body not reaching the extremity of the eighth segment with a cap which a little surpasses it; ninth segment cylindrical, equal, truncate, bearing a pair of cerci, straight, rather stout, but compressed, equal and apically very briefly and bluntly bifid plates, nearly as long as the segment.

Length of body, male, 50 mm., female, 42 mm.; antennæ, male, 22 mm., female, 26 mm.; head, male, 2.5 mm., female, 2.5 mm.; thorax, male, 23 mm., female, 18.5 mm.; mesothorax, male, 12.5 mm., female, 9 mm.; abdomen, male, 23.5 mm., female, 22 mm.; fore femora, male, 14 mm., female, 10.5 mm.; middle femora, male, 11.5 mm., female, 8 mm.; hind femora, male, 14 mm., female, 10.5 mm.; width of metathorax in middle, male, 1 mm., female, 1.5 mm. 1 male, 1 female. Between Mesilla Park and Little Mountain, July 1. (A. P. Morse.)

The female is probably not quite mature.

PSEUDOSERMYLE BANKSII, new species.

Body very slender, testaceous, paler below. Head pale, slightly longer than the pronotum and distinctly swollen anteriorly, the sides marked with a longitudinal black stripe and with the usual longitudinal carinæ on top between and behind the eyes. Body smooth, with scarcely a trace of a median carina; mesothorax much longer than the metathorax. Seventh segment of the abdomen slightly shorter than the eighth and ninth together and considerably swollen on the posterior half, and here furnished with the usual ventral appendage, which is slightly longer than the eighth segment; eighth and ninth segments subequal in length, the latter the larger and equal. The cerci are as long as the last abdominal segment, moderately slender, slightly compressed, curving very slightly downward and inward, and are apically trifid, the center branch curving inward quite abruptly and forming the terminus of the main body of the cerci.

Length of body, 64 mm.; antennæ, 50 mm.; mesothorax, 16.5 mm.; metathorax, including the intermediary segment, 12 mm.; fore femora,

25 mm.; middle femora, 22 mm.; hind femora, 25 mm.; width at the middle of the mesothorax, 1.25 mm.

One male from Brazos County, Texas, collected in September by Mr. Nathan Banks, in whose honor the species is named. Also a male from Buna, Jasper County, Texas, on November 15, 1902, by Dr. A. D. Hopkins. The latter specimen was taken on pine.

Type.—No. 6616, U.S.N.M.

This insect may prove to be the male of *Sermyle strigata* Scudder, but more material is needed before it can be proven. The very slender form, however, seems to militate against this.

BACUNCULUS Burmeister.

Bacunculus BURMEISTER, Handb. Ent., II, 1838, p. 566.

Burmeister established *Bacunculus* as a subgenus of *Bacteria*. As represented in the United States, the genus is defined as follows:

Very closely allied to *Diapheromera*. Head smooth in both sexes, subcylindrical, anteriorly swollen, elongate, more than twice as long as broad, and horizontally attached to the thorax. Antennæ much more than twice as long as the anterior femora. Prothorax about one-sixth as long as the mesothorax; mesothorax slightly longer than metathorax. Legs of male unarmed, slender, filiform; middle femora of male not at all swollen as they are in *Diapheromera;* legs of female usually unarmed, but the middle and posterior femora are sometimes armed below on the median line next the apex with a distinct, though usually minute, spine. Body of male more slender than in *Diapheromera* and the cerci of similar shape and relative proportion as in that genus.

The unswollen middle femora of the males make it easy to distinguish this genus from *Diapheromera*, but from female specimens alone it is more difficult. The more elongate and anteriorly swollen head together with the more generally unarmed legs will usually serve, however, to distinguish the females with considerable certainty.

In the United States we have a single species.

BACUNCULUS TENUESCENS Scudder.

Plate LVI, figs. 1, 2.

Bacunculus tenuescens SCUDDER, Cat. Orth. U. S., app., 1899, p. 95.

This species is figured on Plate I, figs. 1 and 2 of the above work, and described in the following words:

> Body exceedingly slender, flavous beneath, brown (male) or green (female) above, becoming infuscated on the lower portion of the sides, forming a postocular stripe. Head greatly elongated, much longer than the pronotum; antennæ much shorter than the body. Entire body quite smooth with a very delicate mesial carination. Seventh and ninth abdominal segments of male subequal in length, slightly longer than the eighth and about half as long as the sixth, the seventh segment scarcely

inflated, bearing beneath a deflexed subspatulate convex plate, reaching the tip of the eighth segment and no broader than it; ninth segment cylindrical, equal, truncate, bearing a pair of decurved and incurved, cylindrical but slightly clavate, blunt tipped cerci, about as long as the segment.

Length of body, male, 64.5 mm., female, 53 mm.; antennæ, male, 41 mm., female, 35 mm.; head, male, 3.25 mm., female, 3.5 mm.; thorax, male, 31.5 mm., female, 25 mm.; mesothorax, male, 16 mm., female, 13 mm.; abdomen, male, 30 mm., female, 25 mm.; fore femora, male, 18 mm., female, 15.5 mm.; middle femora, male, 14.5 mm.; female, 13.5 mm.; hind femora, male, 20 mm., female, 16 mm.; width of mesothorax at middle, male, female, 1 mm.

One male, one female. Cedar Keys, Fla., June 6; Capron, Florida.

The tip of the abdomen of the female is lost.

The female from which the above description was made is evidently immature, as the measurements do not at all agree with those of mature individuals in the collection of the U. S. National Museum. The following notes are made from a mature female collected by Hubbard and Schwarz at Cedar Keys, Florida, in the month of June:

Color uniformly light greenish-brown, probably green in life. Ninth abdominal segment slightly longer than the seventh. Supraanal plate subtriangular, mesially keeled. Cerci long and slender, about as long as the last abdominal segment. Extreme length of body from front of head to tip of cerci, 85 mm., head 4.5 mm., mesothorax 19 mm., metathorax 14.5 mm., fore femora 19 mm., middle femora 16.5 mm., hind femora 20.5 mm., cerci 4 mm,; width of mesothorax at middle 2 mm.

A female specimen from Biscayne, Florida, from the Riley collection, which is referred to this species, is apparently much above the ordinary size, giving the following measurements: Extreme length of body 110 mm., head 5.5 mm., mesothorax 24 mm., metathorax 19.5 mm., fore femora 27.5 mm., middle femora 21 mm., hind femora 26 mm., cerci 4 mm. This specimen is but little thicker than moderate-sized individuals and shows no peculiarities indicative of a new species.

The brown color of the males of this species varies from light to quite dark, and the legs, probably also the body in some specimens, are greenish-brown.

DIAPHEROMERA Gray.

Diapheromera GRAY, Syn. Phasm., 1835, p. 18.

This genus has the following characters:

Head smooth in both sexes, subquadrate or subcylindrical, usually less than twice as long as broad and obliquely attached to the thorax; antennæ much more than twice as long as the anterior femora; prothorax usually less than one-fourth as long as the mesothorax; meso- and metathorax subequal in length. Body linear, especially in the male; basal segment of abdomen oblong, in male twice as long as broad. Middle femora much swollen in the male, distinctly thicker than the hind ones, those of the female scarcely swollen and not distinctly larger than the hind ones. Posterior femora armed beneath on median line near the apex with a single spine, in the male large and distinct, in the

female sometimes large and distinct but usually much smaller than in the male and sometimes minute or even wholly absent. Cerci of male cylindrical, longer than the last abdominal segment and, except in *D. mesillana*, strongly incurved.

Our common northern walkingstick belongs to this genus, the species of which are distributed more widely over our country than those of any other of our genera. None of the species have been found west of the Rocky Mountains. Five species occur in the United States. They may be separated by the following table, which is for the greater part taken from a paper on this genus by Dr. Scudder:[a]

a. Male cerci strongly incurved.
- *b.* Ninth abdominal segment of male subequal, scarcely larger at apex than at base, the seventh segment much longer than the eighth; male cerci with a basal tooth.
  - *c.* Inner ventro lateral carina of the posterior femora with minute serrations; meso- and metathorax unicolorous.
    - *d.* Male cerci with a blunt tooth at inner inferior base (Plate LVIII, fig. 6); female cerci relatively stout, about half as long as the last dorsal segment. *femorata* Say.
    - *dd.* Male cerci with a sharp thorn at inner inferior base (Plate LVIII, fig. 5); female cerci relatively slender, almost or quite as long as the last dorsal segment .... *veliei* Walsh.
  - *cc.* Inner ventro-lateral carina of the posterior femora smooth; meso- and metathorax longitudinally marked with black beneath. *arizonensis*, new species.
- *bb.* Ninth abdominal segment of male apically inflated, and here nearly half as broad again as at base, the seventh and eighth segments of subequal length; male cerci without a basal tooth .... *carolina* Scudder.

aa. Male cerci rigidly straight .... *mesillana* Scudder.

DIAPHEROMERA FEMORATA Say.

Plate LVII, fig. 4; Plate LVIII, fig. 6.

Spectrum femoratum SAY, Exp. Long., II, 1824, p. 297; Amer. Ent., III, 1828, p. 37, pl. XXVII.—LEIDY, Proc. Acad. Nat. Sci. Philad., III, 1846, pp. 80–84.
Diapheromera femorata HARRIS, Treat. Ins. Inj. Veg., 1840, p. 119.—SCUDDER, Psyche, IX, 1901, p. 188.
Phasma (Bacteria) femorata HAAN, Bijdr. kenn. Orth., 1842, pp. 101, 134.
Bacunculus femoratus UHLER, Harris, Treat. Ins. Inj. Veg., 3d ed., 1862, p. 146.
Diapheromera sayi GRAY, Syn. Phasm., 1835, p. 18.
Bacteria sayi CHARPENTIER, Orth. descr., 1841–1845, pl. IV.
Bacteria (Bacunculus) sayi BURMEISTER, Handb. Ent., II, 1838, p. 566.
Bacunculus sayi THOMAS, Trans. Ill. St. Agric. Soc., V, 1865, p. 441.
Bacteria linearis GOSSE, Lett. Alab., 1859, p. 275.

Color fuscous or green, the males more often exhibiting the latter color. Mature individuals, especially the females, are almost always fuscous during the autumn months. The middle femora of the dark colored males are distinctly banded with lighter color.

Head smooth in both sexes, subquadrate, scarcely elongate, obliquely

[a] Psyche, IX, 1901, pp. 187–189.

attached to the thorax; eyes round, slightly more prominent in the male than in the female. Antennæ long and slender, about as long as the body; prothorax short, about one-fifth as long as the mesothorax, the dorsal cruciform impression distinct, especially the transverse incision; meso- and metathorax subequal in length, without median carina. Legs of male long and slender, except the middle femora, which are much swollen and distinctly thicker than the others; of the female, shorter in proportion, and the middle femora are not swollen, no thicker than the others. Fore legs unarmed, undulate and smaller at the base; hind and middle femora of the male armed beneath on the median line near the apex with a large, prominent spine; of female, similarly armed, but the spine is much smaller, often quite minute. Abdomen smooth; intermediary segment visible only from above and firmly united to the metathorax; basal segment elongate, nearly or quite twice as long as broad in the female and three times as long as broad in the male; seventh segment in the male distinctly longer than the ninth and three times as long as the eighth. Cerci of male somewhat longer than the terminal segment of the abdomen, cylindrical, oval at apex, bluntly tubercled interiorly at base, clothed with microscopic stiff hairs and strongly curved horizontally inwards, usually crossing each other at about the middle; female cerci straight, stout, acuminate, less than half as long as the terminal segment of the abdomen, and partially concealed from above by the exposed tip of the triangular supraanal plate, which, as well as the cerci, is sparsely covered with very short hairs of microscopic size.

Length of body, male, 72 mm., female, 70 mm.; mesothorax, male, 17 mm., female, 16 mm.; metathorax, male, 16 mm., female, 13.5 mm.; middle femora, male, 15.5 mm., female, 11.5 mm.; hind femora, male, 19.5 mm., female, 15 mm.; hind tibia, male, 25 mm., female, 16 mm.

The above description was drawn up from a male and female collected in copulation at Rosslyn, Virginia, on September 12, 1900. The males are quite uniform in size, but the females are quite variable, the one from which the above measurements were taken being a small specimen. A large female from Massachusetts before me gives the following measurements: Length of body, 92 mm.; mesothorax, 19 mm.; metathorax, 17 mm.; middle femora, 14.5 mm.; hind femora, 18.5 mm.; hind tibia, 20 mm.

This species is our most common phasmid and occurs throughout the northern part of the country from the Rocky Mountains eastward. It is said to also occur as far south as Mexico, but is more rare in the South, being quite generally replaced there by the next species, *atlas*. Many of the southern records pertain to allied species mistaken for *femorata*.

These insects mate in the autumn and pairs are often seen in the act

of copulation. The female drops the eggs at random in the woods, where they lie till the following spring before hatching. Eggs deposited on November 9 and kept indoors gave forth the young during the last week of the following March. Some eggs are slow in giving forth the nymphs and so the insect may be found in various stages of development all through the season. Some of the eggs lie through even the second winter before hatching. The young are said to pass through but two stages in the course of growth, which averages less than two months. The newly hatched nymphs are of a uniform pale yellowish-green color and measure about 5 mm. in length, ones reared at the insectary of the Division of Entomology giving the following measurements: Length of body, 8 mm., hind femora, 3.5 mm. The young are said to live on low herbage and drop to the ground when disturbed. There is but one generation annually.

This is the only one of our phasmids that is of economic importance. It has been recorded as occurring in injurious numbers on forest trees. In such cases burning over the ground in winter to kill the eggs is recommended.

DIAPHEROMERA VELIEI Walsh.

Plate LVIII, fig. 5.

Diapheromera velii Walsh, Proc. Ent. Soc. Philad., III, 1864, pp. 409–10.—Scudder, Psyche, IX, 1901, p. 189.

This species may be defined as follows:

Of the same size and form as *D. femorata*, and also agreeing with it in being dimorphic in color, both brown and green forms occurring. It differs from that species in the following particulars: Head slightly more elongate; middle femora of male not usually banded with gray; seventh abdominal segment of the male no longer than the ninth, while in *femorata* it is one-fourth longer. Male cerci with a sharp spine or tooth at the base on the inner side instead of a blunt tubercle; female cerci nearly or quite as long as the apical segment of the abdomen instead of less than half as long, and they are usually more slender than in *femorata*. In general, the color of the dark form of *veliei* seems to be somewhat lighter than that of the corresponding form of *femorata*, but in this respect both species are variable.

This species is more southern in its distribution than *femorata*. It occurs east of the Rocky Mountains from Nebraska to Maryland, south to Georgia and Texas. It occurs also in Mexico. It was described from Nebraska, and Scudder reports it from a number of States within the region specified above. I have seen specimens from Virginia, Kansas, Oklahoma, Texas, and Colorado. Some of the females from Oklahoma have the spine beneath the posterior and intermediate femora entirely aborted, causing them to be separable from

the females of *Bacunculus* only with great difficulty. The shape of the head and the association of the males with the females, however, made the identification quite certain.

DIAPHEROMERA ARIZONENSIS, new species.

Slenderer than *D. femorata*, uniformally light yellowish brown, with the meso- and metathorax longitudinally marked beneath with shiny black. Antennæ nearly as long as the body and concolorous with it. Thorax smooth, with a very slight median carina; mesothorax slightly longer than the metathorax; seventh segment of the abdomen distinctly longer than the ninth, somewhat constricted on the anterior third; ninth segment with the posterior margin concave, exposing the tip of the triangular supraanal plate. Cerci shaped as in *femorata* and *veliei*, with the basal tooth intermediate between those species. Legs long and slender, the middle femora relatived; less swollen than in allied species.

Length of body, 76 mm.; antennæ, about 65 mm.; mesothorax, 18 mm.; metathorax, 16.5 mm.; middle femora, 18 mm.; hind femora, 22.5 mm.

One male, Hot Springs, Arizona, June 28, 1901. Collected by Messrs. Schwarz and Barber.

Type.—No. 6612, U.S.N.M.

This species is closely allied to *femorata* and *veliei*, but can be distinguished from them by the characters given in the table and by the more slender form. The elongate seventh abdominal segment will readily separate it from *veliei*. It is quite a characteristic-looking species, though the differences that separate it from its allies are difficult to define.

DIAPHEROMERA CAROLINA Scudder.

Diapheromera carolina SCUDDER, Psyche, IX, 1901, p. 188.

The following is the description as given by the author:

Stouter than *D. femorata*, testaceo-castaneous, glistening, the thorax with a rather broad median bronze-fuscous stripe, not reaching the median segment, and interrupted at the posterior end of the mesonotum, the fore legs greenish, the antennæ testaceous; thorax with excessively fine transverse striation. Mesothorax and metathorax (including median segment) of similar length. Seventh and eighth abdominal segments of subequal length, each faintly enlarging from base, the ninth a little shorter, apically inflated and subglobose, nearly half as broad again at apex as at base, the cerci much as in *D. femorata*, but stouter, more compressed, and without basal tooth.

Length of body, 67 mm.; head, 3 mm.; mesothorax, 13.5 mm.; fore femora, 20.5 mm.; hind femora, 19.5 mm.

One male. North Carolina. (Morrison.)

DIAPHEROMERA MESILLANA Scudder.

Diapheromera mesillana Scudder, Psyche, IX, 1901, p. 189.

The original description is here given in full.

Slenderer than *D. femorata*, uniform greenish flavous, the antennæ infuscated beyond the basal third, the thorax smooth, with an obscure median carina; subapical inferior spine of middle and hind femora rather slight. Mesothorax and metathorax (including median segment) of equal length. Seventh and ninth abdominal segments subequal in length and distinctly longer than the eighth, all equal in width and nowhere enlarged, the ninth rather feebly and angularly emarginate, exposing a small, transverse, apically arcuate, supraanal plate; cerci about as long as the ninth abdominal segment, rigidly straight, directed backward and not at all downward, slender tapering, blunt tipped, externally convex, and internally concave.

Length of body, 55 mm.; head, 3 mm.; antennæ, circa 37 mm.; mesothorax, 12.5 mm.; fore femora, 14.5 mm.; middle femora, 11 mm.; hind femora, 13.5 mm.

Two males. Between Mesilla and Las Cruces, New Mexico, June 30. (A. P. Morse.)

MEGAPHASMA, new genus.

Head smooth, rounded, subvertical; antennæ more than twice as long as the anterior femora; prothorax one-fifth as long as the mesothorax and transversely incised; meso- and metathorax subequal in length and with a distinct, though slight, median carina. Middle and hind femora swollen in both sexes, the middle ones somewhat larger than the posterior ones in the male, and both the middle and posterior pairs in both sexes armed beneath on the median line next the apex with a prominent spine and sometimes, at least in the female, with a row of equally large ones extending along the entire length of the femora below.

This genus is erected for that large Southern walkingstick described by Stål as *Diapheromera dentricus*. This insect exhibits characters that are certainly of generic value. The rounded, subvertical head, broad, spatulate cerci and unusually large size will readily separate it from all other of our genera. *Diapheromera* is the most nearly allied genus, but the characters given in the table will at once separate it from that genus of much smaller insects.

In the United States we have a single species.

MEGAPHASMA DENTRICUS Stål.

Plate LVII, fig. 2, *2a*, *2b*.

Diapheromera dentricus Stål, Rec. Orth., III, 1875, p. 76.—Scudder, Psyche, IX, 1901, p. 187; Harpers Mag., LXXXVIII, 1894, p. 456, fig. 1.

This species was originally described from Opelousas, Louisiana. The following description is made from specimens, male and female, in the U. S. National Museum collection:

Yellowish brown or fuscous. Head rounded, subvertically attached

to the thorax. Antennæ multiarticulate,[a] more than twice as long as the anterior femora. Cruciform impression on the pronotum distinct, meso- and metathorax subequal in length and furnished above with a scarcely perceptible delicate median carina. Ninth abdominal segment slightly longer than the seventh. Legs stout, anterior ones unarmed and but half as thick as the others; posterior and middle tibiæ deeply denticulate below on the median carina, which is considerably elevated and terminated at the apex in a blunt spine, as is also the posterior ventro-lateral carinæ. The posterior and intermediate femora are large and regularly trapezoidal in form, each border below denticulate and spined on the median line with small apinules, except the terminal one, which is very large in the male. In the female all the spines are often large, but not so large as the terminal one of the male; the femora are broadest on the lower side and slightly swollen toward the base. The male femora are somewhat more rounded than those of the female. Posterior femora extending to the apex of the third abdominal segment in the female and almost to the middle of the fourth in the male; margins above coxal cavities slightly expanded and dentate. Cerci stout, in female less than one-half as long as the last abdominal segment; in male expanded apically, somewhat spatulate and directed strongly downward.

The original description, which was made from the female sex alone, gives the following measurements: Length of body 123 mm.; thorax 53 mm.; mesothorax 24 mm.; metathorax 24 mm.; abdomen 70 mm.; fore femora 27 mm.; middle femora 20 mm.; posterior femora 23 mm.; width of middle of mesothorax 5 mm.

Often the general color is reddish brown, legs lighter. A specimen in the U. S. National Museum collection has the middle and hind femora and the posterior two-thirds of the prothorax green, variegated with light gray and brown; on the femora the gray is grouped together in the form of broad, illy defined bands. Other specimens have the anterior portion of the prothorax and mesothorax, both above and below, greenish black.

This insect has been recorded from Louisiana, Texas, New Mexico, and, with doubt, from Alabama. One female specimen in the U. S. National Museum is from East Joplin, Missouri, the most northern locality yet recorded for this species.

This is the largest walkingstick that occurs in the United States, a female before me measuring 145 mm., which is 5 mm. less than one in the collection of the Academy of Natural Sciences of Philadelphia. This species suggests tropical forms more than anything else in our

[a] The antennal segments of a male specimen from Texas were counted and were found to number just seventy-eight. The antennæ of the specimen figured is drawn nearly twice too thick, except basally.

fauna, and the large size commands attention wherever seen. Mr. Mitchell, of Victoria, Texas, informs me that they are not uncommon in the wooded bottoms in that vicinity, where they occur on grape vines.

Subfamily ANISOMORPHINÆ.

In this subfamily the antennæ are more than twice as long as the anterior femora. Tibiæ furnished with a sunken areola below next the apex; coxæ visible from above; tarsi distinctly pentamerous. Mesothorax not more than three times as long as the prothorax. Intermediary segment invisible.

We have a single genus of this subfamily in the United States.

ANISOMORPHA Gray.

Anisomorpha Gray, Syn. Phasm., 1835, p. 18.

This genus, as represented in the United States, has the following characters:

Head not more than one and one-half as long as broad, horizontally attached to the thorax. Body broad and stout, especially in the female; prothorax furnished with distinct odoriferous glands; meso- and meta-thorax subequal in length. Legs stout and thick, unequal, the middle pair the shortest; abdominal segments subquadrate or transverse, especially in the female, the seventh and ninth subequal in length, intermediary segment invisible. Cerci short, rounded, similar in both sexes.

We have two closely allied species, one occurring more commonly in the extreme Southern States and the other ranging farther north. Their differences are comparative and may be tabulated as follows:

a. Female, color generally yellowish brown with conspicuous broad black dorsal and lateral stripes. Head noticeably longer than broad; body more elongate, seven to nine times as long as broad. Male, color and head as in female. Body still more elongate, about twelve times as long as broad, averaging about 45 mm. in length .... *buprestoides* Stoll.

aa. Female, color uniformly ferruginous of various shades or inconspicuously striped with very narrow dusky dorsal and lateral stripes. Head less noticeably longer than broad. Body proportionately shorter and broader, six to six and one-half times longer than broad. Male, color same as female. Head and proportions about the same as in *buprestoides* but smaller, averaging no more than 35 mm .... *ferruginea* Palisot.

ANISOMORPHA BUPRESTOIDES Stoll.

Plate LIX, fig. 1.

Phasma buprestoides Stoll, Repr. Spectr., 1787–1813, p. 68, pl. xxiii, fig. 87.
Anisomorpha buprestoides Gray, Syn. Phasm., 1835, p. 19.—Scudder, Can. Ent., XXVII, 1895, p. 30.
Phasma (Anisomorpha) buprestoides Haan, Bijdr. Kenn. Orth., 1842, p. 101.
Spectrum bivittatum Say, Amer. Ent., III, 1828, pl. xxxviii.
Spectrum vittata Jaeger, Life N. Amer. Ins., 1854, p. 123.

The following description of this common Southern walking-stick is made from a series of both sexes in the collection of the United States National Museum.

Color varying shades of yellowish brown, often almost fuscous, with conspicuous broad, black stripes extending from the front of the head to the tip of the abdomen, one dorsal and one on each side. These stripes, in dark-colored individuals, are often more or less confused, but in light-colored specimens they are very conspicuous and well defined. Some specimens, apparently killed soon after transformation, are paler in color and with the stripes narrow and indistinct. Legs short and stout, unequal, the middle pair the shortest, in male more slender than in the female, dark colored, except in light-colored individuals, where they are colored the same as the body; the tibiæ and femora of each pair of legs are subequal in length. Head noticeably longer than broad, horizontally attached to the thorax and subquadrate in shape, somewhat swollen anteriorly. Antennæ about three times as long as the anterior femora, the fourth segment the shortest. Prothorax mesially incised and transversely sulcate in the middle, about twice as long as broad, usually more than one-third as long as the mesothorax, furnished above on each well-elevated border in front with a prominent gland, opening laterally from which is ejected a pungent spray when the insect is excited. Meso- and metathorax subequal in length, the former usually slightly the longer and on the disk sometimes furnished, especially toward the sides, with several granules, often quite acute; there is no median carina. Abdomen smooth, without carina, segments, especially the basal ones of the female, subquadrate or transverse, in the male usually somewhat longer than broad, intermediary segment invisible. In the female the seventh segment beneath forms a large scoop-shaped process, at the base of which are situated the genital organs. Cerci short, in the female no more than one-half as long as the last abdominal segment, in the male almost as long as the apical segment, straight and subcylindrical in both sexes, projecting subhorizontally backward in the female and subperpendicularly downward in the male. The male usually has the tip of the abdomen curved under.

Measurements made from a mated pair from Key West, Florida, are as follows: Length of body, male 45 mm., female 61 mm.; head, male 3.5 mm., female 6 mm.; antennæ, female 40 mm.; prothorax, male 3.5 mm., female 6 mm.; mesothorax, male 7 mm., female 12 mm.; metathorax, male 6 mm., female 10 mm.; fore femora, male 9.5 mm., female 13 mm.; middle femora, male 7 mm., female 10.5 mm.; hind femora, male 9.5 mm., female 14 mm.; width of head, male 2.5 mm., female 4 mm.

This species, which is sometimes called the musk mare, seems to occur most commonly in the extreme Southern States. The U. S.

National Museum contains over twenty specimens, all from Florida, except some without labels, which are probably from Mississippi. It has been recorded from various localities in the southeastern part of the United States, but the more northern records doubtlessly belong to the next species. Several young specimens referable to this species are uniformly brownish gray in color, but otherwise resemble the adults.

ANISOMORPHA FERRUGINEA Palisot de Beauvois.

Plate LIX, fig. 2.

Phasma ferruginea Palisot de Beauvois, Ins. Afr. Amer., 1805–1821, p. 167, pl. xiv, figs. 6, 7.
Anisomorpha ferruginea Gray, Syn. Phasm., 1835, p. 18.
Phasma (Anisomorpha) ferruginea Haan, Bijdr. Kenn. Orth., 1842, p. 101.

This species is very closely allied to the preceding one. The color is in general lighter than in *buprestoides* and usually uniform, and not conspicuously marked by black stripes as in that species, sometimes with narrow stripes, more often noticeable in the males. The head is usually less noticeably longer than broad, and the body is proportionately shorter and broader as tabulated above. The males average less in size and the habitat seems to extend farther north than that of *buprestoides*. The measurements from a pair from Tallulah, Georgia, are as follows:

Length of head, male 3 mm., female 5.5 mm.; body, male 31 mm., female 50 mm.; fore femora, male 8 mm., female 10 mm.; middle femora, male 5.5 mm., female 8.5 mm.; hind femora, male 8 mm., female 11 mm.; prothorax, male 2.5 mm., female 5 mm.; mesothorax, male 5 mm., female 9.5 mm.; metathorax, male 4 mm., female 8.5 mm.; width of head, male 2 mm., female 4.5 mm.

This species appears to extend farther north than *buprestoides*, but it also occurs in Florida. The specimens in the collection of the United States National Museum are from Florida, Louisiana, Kentucky, and Pennsylvania.

This species, as well as the preceding one, is said to be able to throw a colored fluid to a considerable distance from the well-developed scent glands, situated on the thorax.

TIMEMINÆ, new subfamily.

This subfamily presents the following characters:

Antennæ longer than the anterior femora; tibiæ furnished beneath at the apex with a sunken areola; coxæ invisible from above; tarsi three jointed. Intermediary segment as distinct as the rest of the abdominal segments, freely articulated to the thorax and not at all connate with it as in all other of our groups.

This well-defined subfamily is proposed for the genus *Timema* of

Scudder. The structure of the insects here included is different from all other of our Phasmidæ, as is shown by the legs being attached beneath the body in such a manner as to conceal the coxæ from above. The three-jointed tarsi are also peculiar to this subfamily. The three-jointed tarsi are obviously the result of a unition of the first three segments of the normal pentamerous phasmid tarus. This is indicated by the lower surface of the first segment showing obscure segmentation where the original segments have united.

We have but one genus of this interesting subfamily in the United States.

TIMEMA Scudder.

Timema Scudder, Can. Ent., XXVI, 1895, p. 30.

The characters limiting this genus are:

General form short and broad, not linear, head subquadrate, no longer than broad, as broad as the thorax. Antennæ much longer than the anterior femora, basal segment very large, three times as long as broad, enlarged apically. Prothorax quadrate, not narrowed anteriorly, no shorter than the metathorax and without distinct odoriferous glands; meso- and metathorax subequal in length. Legs short and stout; cerci of male forcipulate, irregular in shape and curving inwards, of female stout, vertically flattened and straight, in both sexes longer than the last abdominal segment.

We have a single species.

TIMEMA CALIFORNICA Scudder, new species.

Plate LVII, fig. 5; Plate LVIII, figs. 7, 7*a*.

This species, the type of the genus, has never been described. Dr. Scudder has very kindly furnished the following description, which is here published for the first time:

Head large, thorax depressed, abdomen depressed cylindrical, expanding somewhat posteriorily, the whole body smooth, glistening a little, nearly uniform luteo-testaceous with a faint greenish tinge, the abdomen slightly lighter in tint than the thorax, the latter striped longitudinally and narrowly with brownish fuscous, most distinctly in a submarginal stripe, in which are fuscous impressed puncta. Antennæ about as long as head and thorax together. All the legs short, the hind femora about as long as the first three abdominal segments. Last abdominal segment of male somewhat expanded and tumid, the hind margin sinuato-truncate, the cerci about as the last segment, asymetrical, tortuous, abruptly incurved, basally depressed, apically tapering to a point.

Length of body, male 14.25 mm.; female 22.5 mm.; antennæ, male 5.25 mm.; female 7 mm.; mesonotum, male 1.5 mm.; female 2.5 mm.; hind femora, male 3.25 mm.; female 4.5 mm. One male, one female, Santa Cruz Mountains, California. (L. Bruner.)

The U. S. National Museum contains three typical specimens of this species, two males and one female, from Santa Cruz Mountains, Cali-

fornia, collected by Albert Keobele. The antennæ of the males are broken, but those of the female are intact and measure 14 mm. in length and are 22 jointed. It would therefore appear that the antennæ of Dr. Scudder's specimens, at least those of the female, were broken.

The trochanters of these insects are large and distinct, more so than in any other of our Phasmidæ. The head is marked by a narrow post-ocular stripe, which extends more or less distinctly across the entire length of the pronotum.

Besides these specimens from the Santa Cruz Mountains, the U. S. National Museum contains a male and a female from Los Angeles County, California, that may represent a new species, but their condition is too poor to warrant their description as such without additional and better preserved material. They differ from the typical specimens in being proportionately shorter, head more flattened vertically, without the postoculate black line, and, together with the pronotum in the male, rugose above. The female cerci are more slender, and the meso- and metathorax of both sexes seem less developed than in the specimens from Santa Cruz Mountains. The male cerci also differ in being more foliaceous. Plate LVIII, fig. 7″, shows the male cerci of the specimen from Los Angeles County, and Plate LVIII, fig. 7, the same of the Santa Cruz Mountain specimens.

This species apparently represents a step in the transition from the Phasmidæ to the Forficulidæ. The forcipal cerci of the males, ventrally attached legs, short, broad head, and especially the short, stout legs with the three jointed tarsi, indicate a relation to the ear-wigs. As Phasmids these creatures are certainly anomalies, and at a casual glance are not always readily recognized, having, in one instance at least, been mistaken for a species of Perlid larvæ.

NOTE.

Since this paper has been made up into pages, Mr. E. A. Schwarz collected a specimen of Phasmidæ representing a species new to our fauna. It was taken at Key West, Florida, on April 6, and, except for the discordant factor of the median segment being slightly shorter than the metathorax, seems to fall quite naturally into the Bacterid genus *Haplopus* of Gray. As the specimen is an immature female, any attempt at specific determination would be unsatisfactory. It may eventually prove to be the *Haplopus cubensis* of Saussure, but it does not seem to agree very well with the description of that species.

EXPLANATION OF PLATES.

Plate LVI.

(After Scudder.)

Fig. 1. *Bacunculus tenuescens* Scudder, male.
2. *Bacunculus tenuescens* Scudder, male, side view of the tip of the abdomen.
3. *Pseudosermyle strigata* Scudder, female.

Plate LVII.

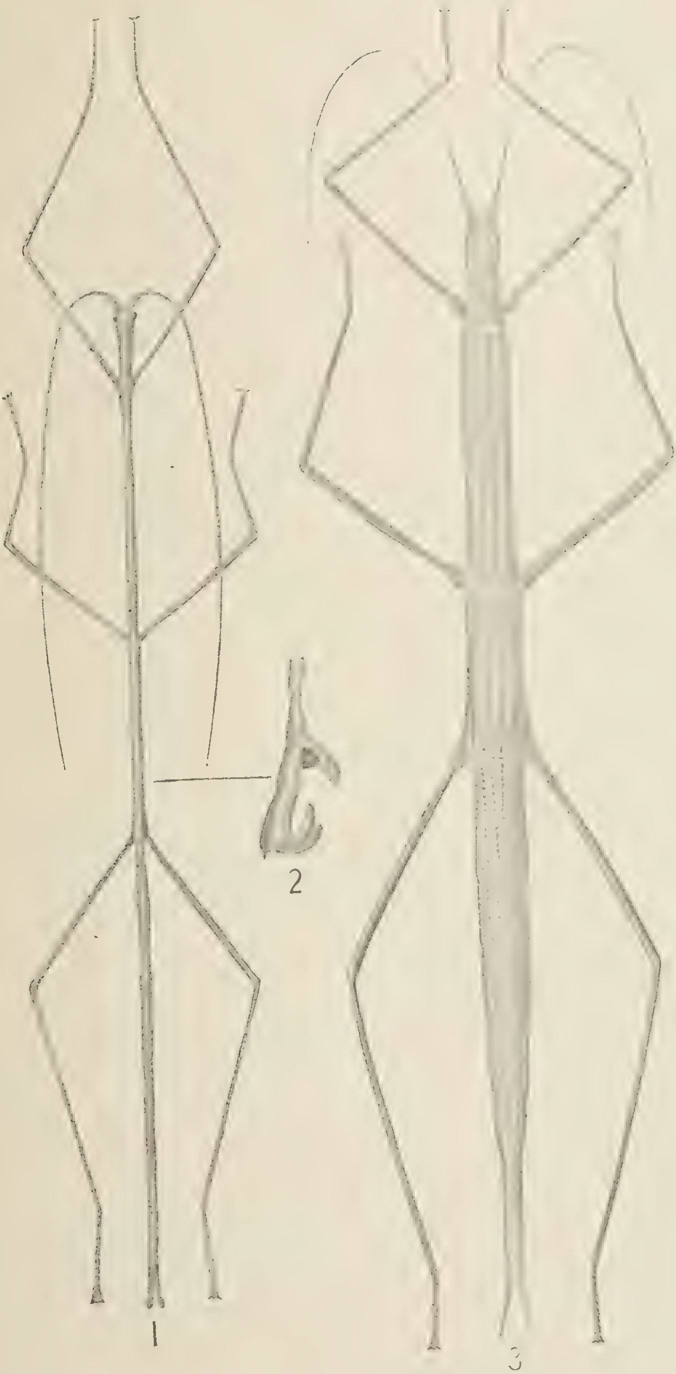
Fig. 1. *Parabacillus coloradus* Scudder, male.
2. *Megaphasma dentricus* Stål, male.
2a. *Megaphasma dentricus* Stål, male, side view of head and pronotum.
2b. *Megaphasma dentricus* Stål, male, side view of the tip of the abdomen.
3. *Pseudosermyle arbuscula* Rehn, female, end of the abdomen.
4. *Diapheromera femorata* Say, male, side view of head and pronotum.
5. *Timema californica* Scudder, female.

Plate LVIII.

Fig. 1. *Parabacillus coloradus* Scudder, female (after Scudder).
2. *Pseudosermyle stramineus* Scudder, male (after Scudder).
3. *Pseudosermyle truncata*, new species, male, side view of the tip of the abdomen.
3a. *Pseudosermyle truncata*, new species, female, right middle leg.
3b. *Pseudosermyle truncata*, new species, female, tip of abdomen.
4. *Pseudosermyle arbuscula* Rehn, female, right middle leg.
5. *Diapheromera veliei* Walsh, male, end of abdomen.
6. *Diapheromera femorata* Say, male, end of abdomen.
7. *Timema californica* Scudder, male, end of abdomen.
7a. *Timema californica* Scudder, variety, male, end of abdomen.
8. *Pseudosermyle strigata* Scudder, female, end of abdomen.

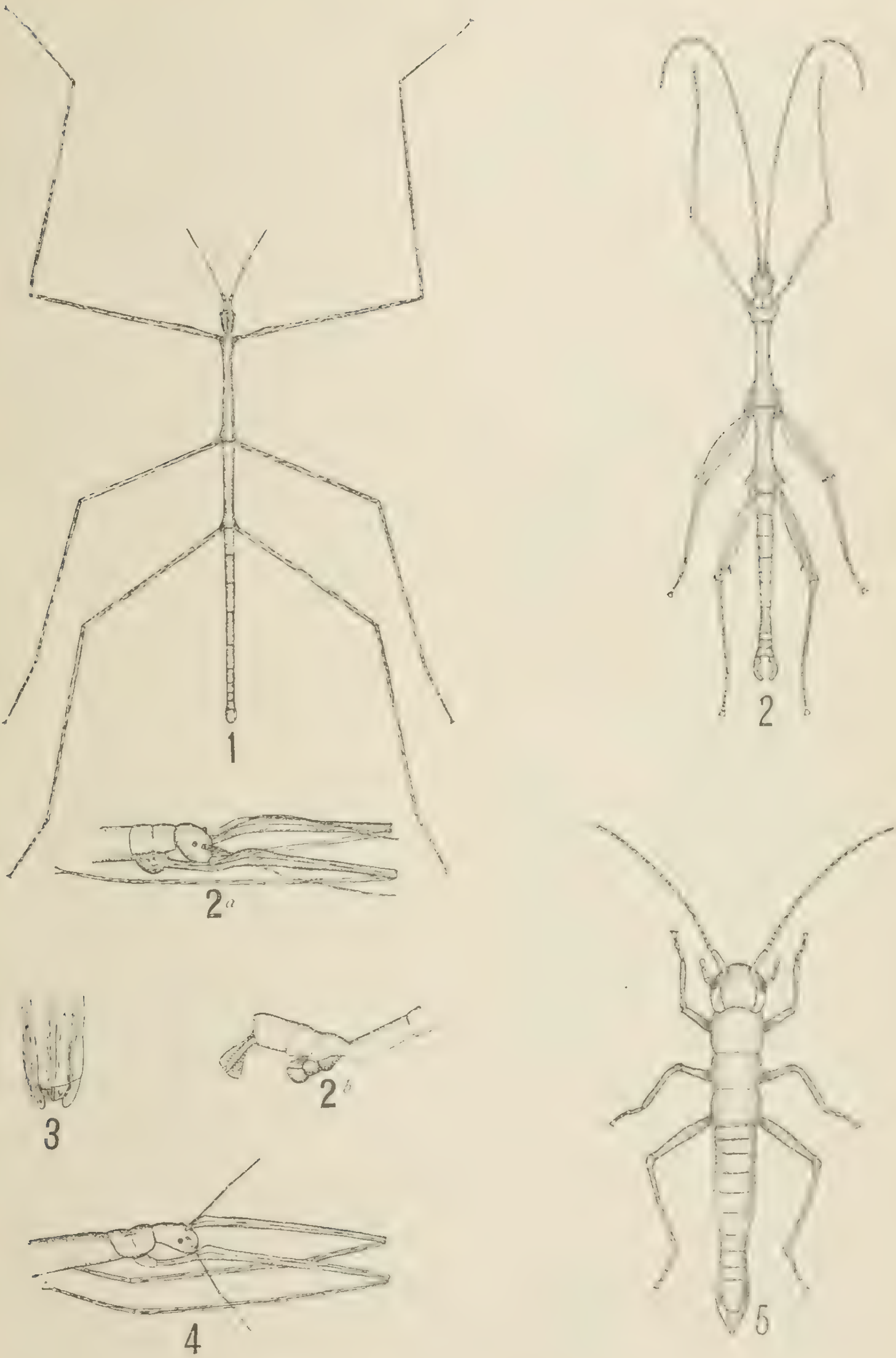
Plate LIX.

Fig. 1. *Anisomorpha buprestoides* Stål, female.
2. *Anisomorpha ferruginea* Palisot de Beauvois, female.



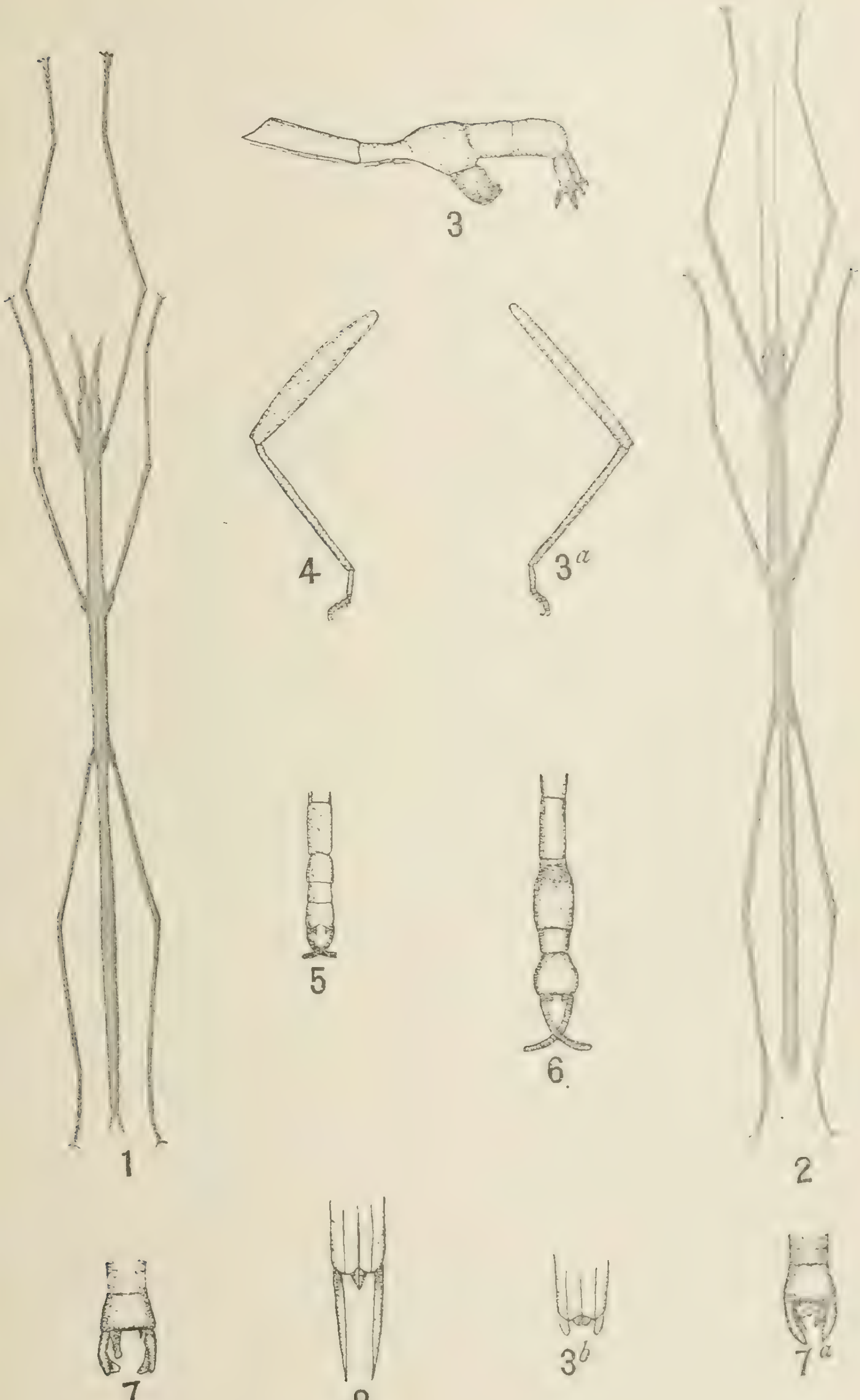
WALKINGSTICKS OF THE UNITED STATES.

FOR EXPLANATION OF PLATE SEE PAGE 884.



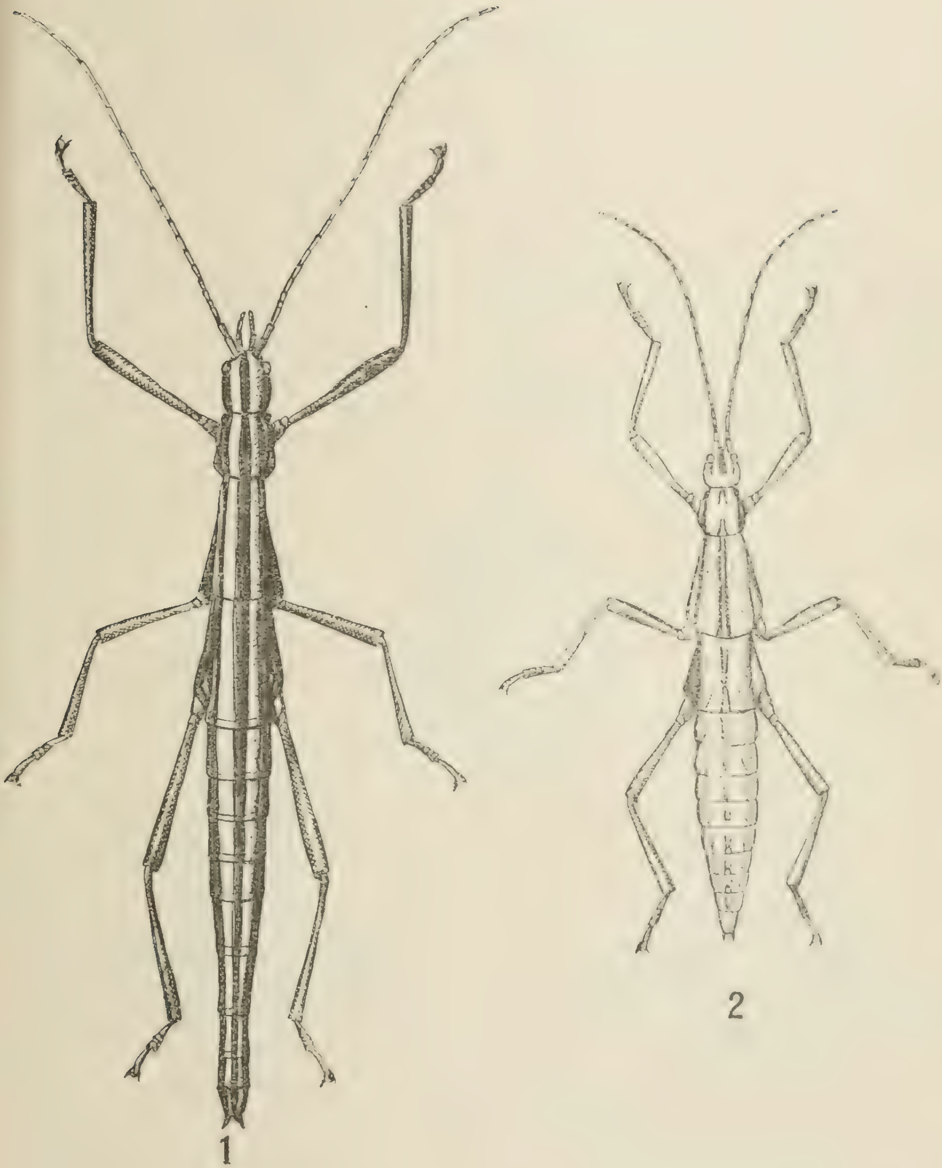
WALKINGSTICKS OF THE UNITED STATES.

FOR EXPLANATION OF PLATE SEE PAGE 884.



WALKINGSTICKS OF THE UNITED STATES.

FOR EXPLANATION OF PLATE SEE PAGE 885.



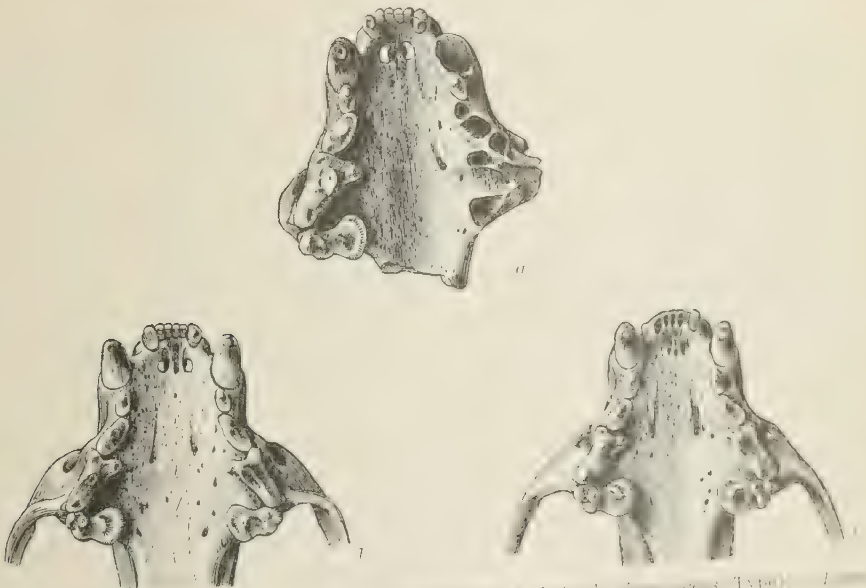
Walkingsticks of the United States.

For explanation of plate see page 885.

DESCRIPTION OF AN EXTINCT MINK FROM THE SHELL-HEAPS OF THE MAINE COAST.

By Daniel Webster Prentiss.

Upon the shores and islands of Penobscot Bay and the adjacent coast there exist numerous shell-heaps, the majority of which were made by Indians. They vary greatly in size, some being an acre in extent, while others cover but a few square yards. The age of the majority of these shell-heaps is unknown, but from the absence of metals and articles of European manufacture from many of them, it is allowable



Palatal aspect of skull—*a*, *Lutreola macrodon* (Type); *b*, *Lutreola* [illegible] (Type); [illegible] *vison lutreocephalus* (No. 36915).

to suppose that these at least date back to pre-Columbian times. This idea is strengthened by the discovery in one of them of the fragment of the skull of a mink, representing an extinct species which appears to be new, and is below described for the first time. Remains of other extinct species of animals will doubtless be detected as our knowledge of the contents of these shell-heaps increases. The drawings illustrate well the specific differences pointed out below.

LUTREOLA MACRODON, new species.

Type specimen.—No. 115178, United States National Museum, collected by F. W. True and D. W. Prentiss in 1897.

Type locality.—Brooklin, Hancock County, Maine.

Condition of type.—Fragment of skull composed of the superior maxillæ, portions of the nasals, right zygoma, and palate extending 6 mm. back of molars. All of the teeth are present on the right side, three incisors and one premolar on the left side. The teeth are in excellent condition except the canine, which is broken at the point, and portions of enamel missing. The bones are very brittle and of a yellowish color on their broken surfaces.

Description.—Rostrum very wide, nasal aperture large, ant-orbital foramina also large. The nasals ascend more abruptly than in *L. vison lutreocephalus*, its nearest relative. The dentition is very similar to this race; the principal differences being the large size of teeth and the more acute angle which the carnassial makes with the long axis of the skull.

Measurements.

	Lutreola macrodon. Type.	*L. vison ingens.* Type.[a]	*L. vison lutreocephalus.* 36915 U.S.N.M.[b]
	Mm.	*Mm.*	*Mm.*
Incisor row	8.25	7.5	6.75
Premolar row at base	18.25	17.7	14.50
Palate between canines	9.00	9.00	8.00
Palate between molars	12.50	12.00	11.00
From anterior of incisor row in middle line to posterior part of inner tubercle of molar	30.00	28.00	26.00
Between ant-orbital foramina	22.00	20.00	18.00
Breadth of nasal aperture	9.25	7.5	8.00
Ant-orbital foramen	6 x 4	5 x 3	4.x3
Base of incisor row to tip of nasal	14.25	13.25	13.00

[a] Fort Yukon, Alaska. [b] Near Washington, District of Columbia.

The skulls from which the foregoing measurements were taken are adult. The measurements of *L. macrodon*, compared with those of *L. v. lutreocephalus*, its nearest relative, show the enormous size of this mink. *L. v. ingens* was until now the largest American mink, but is decidedly smaller than the one here described.

The resemblance of this species to *L. v. lutreocephalus* is very striking, but the difference in size of the teeth, the angle of the nasals, and the position of the carnassials justify me, I believe, in the absence of intermediate forms, in describing it as a new species.

I wish to express my thanks to the Secretary of the Smithsonian Institution for permission to study and report upon this specimen, to Dr. C. Hart Merriam for access to the collections of the Biological Survey, Department of Agriculture; to Mr. Gerrit S. Miller, jr.; and to Mr. Outram Bangs, of Boston.

REVISION OF THE CRUSTACEA OF THE GENUS LEPIDOPA.

By James E. Benedict,

Assistant Curator of Marine Invertebrates.

No group of small nonparasitic animals is more inseparably and picturesquely associated with the environment in which the greater numbers live than are the members of the super-family Hippoidea, of which the sand bug, known as *Hippa talpoida*[a] since the time of Say, is the best known representative on the east coast of the United States. Members of this family are occasionally found even as far north as Cape Cod. They live in the sand on open beaches, which have been said to be the most barren of places for a collector with the exception of a desert. Nevertheless a walk along the shore is always interesting. The bleached and broken tests of sea urchins, beach-worn shells of mollusks which have lived beyond the surf lines, and the fragments of innumerable things which the waves cast up, momentarily attract the attention. Living things that occur are but few, and usually well-known species. One may expect to see an occasional swimming crab protecting itself from the surf and perhaps from the collector, by settling back into the sand nearly or quite out of sight, or a running crab hastening to its burrow, or if cut off from this retreat, plunging into the surf out of reach of scoop nets. The long rows of partially dried sea-weed often shelter Amphipods, Isopods, and shore insects, and digging along the water's edge brings to light a few small Annelids and Synaptas, but the hunt alongshore with shovel and sieve where the waves are pounding results usually in finding little but Hippids, which scuttle about the sieve in the vain effort to escape, or if a sieve is not at hand, and the contents of the shovel have been spread upon the beach, quickly disappearing in the sand only to be brought back by a plunge of the hand. But in the warmer American waters, among the Hippids an occasional *Albunea* or *Lepidopa* will be found, seemingly living under the same conditions as the Hippids, though differently fitted for such conditions. Very few specimens of the

[a] Now *Emerita talpoida.* Bull. U. S. Fish Com., II, 1900, p. 138.

Albuneids seem to be present at one time, and the question naturally arises, is this their normal proportion, or do they occur in greater numbers in some more favored locality, perhaps farther out where the sands are not always in motion, and where they would be able to use more deliberately, in feeding, the hands which have been altogether denied their relatives, the Hippids; or do they live deeper in the sand, where their long antennulæ may not only warn them of the presence of prey, but keep the way open and even entice the victim within reach of the strong hands? The answer to this question must be deferred until collectors have recorded more careful and extended observations; and it may not be out of place to here suggest that one reason for the scarcity of individuals is that collectors, having quickly obtained a sufficient number of Hippids for their purposes, do not prolong the search, and so miss a chance to obtain the rarer Albuneids. Between these forms striking differences will be observed. The Hippids are shuttle-shaped, while the Albuneids, except in the case of *Blepharipoda*, are broader across the front than anywhere else. To some difference in habit is possibly due the great difference in the eyes. Those of the Hippids are on slender almost thread-like stalks, while those of the Albuneids are remarkable for the peculiar and diverse shapes of the stalks which furnish characters that may be used not only to distinguish the genera, but to quite an extent, even the species in a genus. In the genus *Albunea* they are flattened, elongated, and in most species acutely triangular in shape, with a small cornea at the apex. In the genus *Lepidopa* they are scale-like, and in some species almost rectangular, while the cornea, if the small speck can be so called, may be situated either on the terminal or lateral margin. It is hard to understand just what is the function of the broad scale-like stalk. The speck which serves for the eye can hardly do more than distinguish light from darkness. In the genera having mere eyespecks on a scale-like stalk the antennulæ are extraordinarily developed. This forces another question upon us: Is not this a case of one sense organ having been developed at the expense of or in compensation for another, for the antennulæ are sense organs of no slight power, being from two to five times the length of the carapace—straight, stiff, and well provided with hairs which are probably sensory. These organs must be more useful than eyes to an animal living submerged in the sand in the situations where they have been found. *Blepharipoda* has yet a different eyestalk, slender as in the Hippids, but jointed in the middle.

FIG. 1.—ANTENNULAE OF LEPIDOPA MYOPS. $\frac{1}{1}$.

The Hippidæ and the Albuneidæ make up the super-family Hippoidea of the Macrura Anomalia.

In this paper four species are described as new, and, though the material is scanty, the localities from which the specimens were obtained are separated by long distances. Of the seven species now included in the genus *Lepidopa* six are represented in the collections of the U. S. National Museum and one in those of the museum of Union University, Schenectady, New York.

GENUS LEPIDOPA Stimpson.

Lepidopa Stimpson, Proc. Acad. Nat. Sci. Phila., 1858, p. 230.

Lepidops Stimpson, Ann. Lyc. Nat. Hist. N. Y., VII, April, 1860, p. 241.—Miers, Revision of the Hippidea, Jour. Linn. Soc. Lond., XIV, Oct., 1878, p. 331.

The Albuneids of this genus may be immediately recognized by the very long, stiff lashes of the antennules or middle antennæ in connection with the broad scale-like stalks which range in form from ovate to quadrate. The carapace in all species is shield shaped, the surface is but little broken by lines.

The characters relied upon to distinguish the species are believed to be those least likely to vary.

KEY TO THE SPECIES OF THE GENUS LEPIDOPA

a'. Eye-stalks ovate.
- b'. With lobe between the central points of the front ---------- *venusta*, p. 892
- b^2. Without lobe between the points of the front ---------- *websteri*, p. 892

a^2. Eye-stalks subrectangular.
- b'. Cornea on the frontal margin of the eye-stalk very small ---------- *myops*, p. 892
- b^2. Cornea on the outer margin.
  - c'. Antero-lateral angle of eye-stalk produced much beyond the side, anterior margin rounded ---------- *deamæ*, p. 893
  - c^2. Antero-lateral angle not produced much, if any, beyond the line of the side, anterior margin straight or very slightly concave.
    - d'. Inner distal angle of the eye-stalk more rounded than the outer. *scutellata*, p. 894
    - d^2. Outer distal angle of the eye-stalk more rounded than the inner.
      - e'. Margin between the central and lateral teeth of the front is occupied by a sinus divided by a lobe into nearly equal parts ---------- *mearnsi*, p. 895
      - e^2. Margin between the central and lateral points occupied by the usual ocular sinus, the lobe not forming a second sinus between it and the lateral teeth of the front ---------- *richmondi*, p. 895

LEPIDOPA VENUSTA Stimpson.

Lepidopa venusta STIMPSON, Proc. Acad. Nat. Sci. Phila., 1858, p. 230 (without description); Ann. Lyc. Nat. Hist. of New York, VII, p. 79.
Lepidops venusta MIERS, Jour. of Linn. Soc. of London, XIV, p. 332.

Eyes oblong, broadest about the posterior third, narrowing toward the cornea, which is terminal and very small, barely visible from above. From below, under a lens, it is shown as a black speck with a little dark streak running to the bottom of the peduncle.

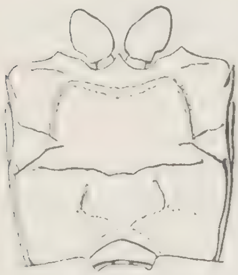


FIG. 2.—LEPIDOPA VENUSTA, 2.

The ocular sinus is separated from the spine behind the antenna by a slight lobe in all specimens. Between the spine and the antero-lateral angle the outline is slightly concave. The front and lateral projections are equally advanced.

Length of carapace of largest specimen, 11 mm.; breadth, 14 mm Savanilla, U. S. Colombia: collected by the U. S. Fish Commission steamer *Albatross;* three specimens.

LEPIDOPA WEBSTERI, new species.

Lepidopa venusta, KINGSLEY, Proc. Acad. Nat. Sci. Phila. for 1879 (Part pub. March 9, 1880), p. 410.

In comparing the single specimen referred to by Mr. Kingsley with *Lepidopa venusta*, it is found to be very closely related, but yet distinct. It differs in having the lateral teeth of the front closer to the rostral tooth, while in *L. venusta* they are closer to the spines of the antero-lateral angles; the lateral teeth of *L. websteri* are also more produced, and the lobe between the base of the rostral tooth and the lateral teeth has almost disappeared from this species, while prominent in *L. venusta*. The eye stalks are in a general way only like those of *L. venusta;* they are not so long in proportion and are not contracted as much near the apex. The specimen can hardly be said to have an eye speck; a dark line on the lower surface may serve to distinguish light from darkness.

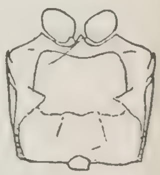


FIG. 3.—LEPIDOPA WEBSTERI, × 2.

The color of this species, as *L. venusta*, also is iridescent.

The carapace is 7 mm. in length and 9 mm. in breadth.

Named for the collector, Prof. H. E. Webster.

The type belongs to Union University, Schenectady, New York, and was taken on the beach near Fort Macon, North Carolina.

LEPIDOPA MYOPS Stimpson.

Lepidops myops STIMPSON, Ann. Lyc. Nat. Hist. New York, VII, 1862, p. 241.—MIERS, Jour. of the Linn. Soc. of London, Zool., XIV, 1879, p. 333, pl. v, fig. 16.

The eyes are broad and very broadly rounded at both angles, the inner distal angle is, however, more evenly rounded than the outer,

which is slightly produced beyond the inner. The eye speck is on the distal margin near the outer angle and the sinus occupied by it could hardly be distinguished with a lens, were it not for the slight coloration remaining.

The front is tridentate. The lateral teeth are acute, while the median tooth is blunt and evenly rounded, situated posterior to the line of the lateral points just 1 mm., in the specimen described. Between the deepest part of the ocular sinus is a broad lobe. Between the lateral point and the antero-lateral angle the margin is deeply concave.


FIG. 4.—LEPIDOPA MYOPS, $1\frac{1}{2}$.

The carapace of this species, like that of scutellata, has a broad, rather depressed ridge running along the median line. The post-branchial area has a group of from 8 to 10 large punctures.

The specimen from which the foregoing description was drawn was obtained by Dr. E. A. Mearns, U. S. A., off San Diego, California.

Type.—No. 28661, U.S.N.M.

LEPIDOPA DEAMÆ, new species.

The eye-stalks of this species are broadest near the anterior end. The inner and distal margins are about equally arcuate and form a slightly obtuse angle where they meet. The anterior exterior angle of the stalk is well rounded; behind this angle the eye spot is well indented. From this place the stalk narrows rapidly to its base.

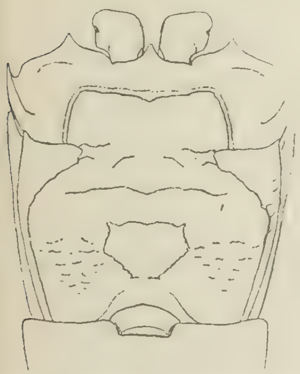


FIG. 5.—LEPIDOPA DEAMÆ, NATURAL SIZE.

The median tooth of the front is advanced to a point nearly in line with the lateral teeth. From the rostral tooth the margin runs backward, making an ocular sinus evenly concave at its inner half; from this point it is straight and almost transverse to the notch where it meets the sigmoid margin and the lateral tooth of the front. From the lateral tooth to the spine at the antero-lateral angle the margin is sigmoid, an exact copy of the sigmoid outline of the margin between the point and the eye sinus, but very much larger.

The carapace is convex transversely, straight longitudinally.

As in scutellata, the median line is raised into a broad carina, triangular in cross section; this is by far the largest *Lepidopa* in the collection. It is 35 mm. broad in front, is 32 mm. long measured on the middle line from the apex of the rostrum to the posterior margin of the carapace. Named for the collector, Mrs. Clarence C. Deam, of Bluffton, Indiana, who obtained the specimen from Salina Cruz, Gulf of Tehuantepec, Mexico.

Type.—No. 26170 U.S.N.M.

LEPIDOPA SCUTELLATA Stimpson.

?*Hippa scutellata* FABRICIUS, Ent. Syst., II, 1793, p. 474.

?*Albunea scutellata* DESMAREST, Consid. sur le Crust., 1825, p. 173.—M. EDWARDS, Hist. Nat. des Crust., II, 1837, p. 204, pl. XXI, figs. 9–13.—GIBBES, Proc. American Assoc., 1850, p. 187.—DANA, U. S. Expl. Exp., XIII, 1852, p. 406.

Lepidopa scutellata STIMPSON, Proc. Acad. Nat. Sci. Phila., 1858, p. 230; Ann. Lyc. Nat. Hist., New York, VII, Mar., 1859, p. 79.

Lepidops scutellata MIERS, Jour. Linn. Soc. Lond., XIV, Oct., 1878, p. 332.

The eye-stalks are nearly rectangular, a little longer than wide. The anterior margin is slightly concave and under a lens is seen to be armed with denticles. The eye-specks are situated on the outer margin just posterior to the rounded portion of the distal angle. These specks are much more prominent in this and other species with rectangular eye-stalks than in species with ovoid stalks. The lateral teeth of the anterior margin are a little more advanced than the middle or rostral tooth, and are placed nearer to the spine of the antero-lateral angle than to this tooth. The margin of the front is sigmoid between the apex of the lateral teeth and the bottom of the ocular sinus. At this point it meets the concave line which forms the margin of the rostral tooth; at the point where the lines meet there is a very small notch. The carapace is broader than long, straight on the median line, and strongly curved laterally.

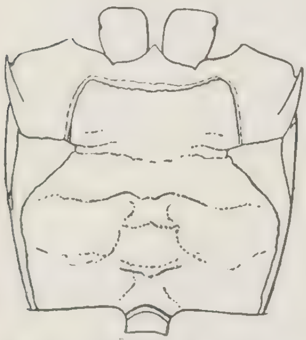


FIG. 6.—LEPIDOPA SCUTELLATA. $\frac{1}{1}$.

The carapace of a female from Pensacola, Florida, measures 16.5 mm. long and 19.5 mm. wide. The eye-stalks are 4 mm. long and 3.4 mm. wide.

An examination of the stomach of a specimen taken near Morris Cut, opposite Miami, Florida, disclosed the setæ of Annelids, the skin of a very small Synapta with some anchor plates still present, and parts of the flagellæ of some small crustacea.

The type locality of the species called *Albunea scutellata* by the earlier authors will probably never be known. When Stimpson erected the genus *Lepidopa* by separating *Albunea*, he placed in it two species from the island of St. Thomas, West Indies. The species with the more rectangular eye-stalks he very properly identified with *Albunea scutellata* of Desmarest, Edwards, and others. This identification he could not have verified nor can we at this time unless the types are extant. As the matter stands the island of St. Thomas can be recognized as the type locality of the species. The specimens in the National Museum do not come from localities nearer St. Thomas than Florida, and it follows that the species here described and figured for *L. scutellata* may prove to be new.

LEPIDOPA MEARNSI, new species.

The eye-stalks are almost rectangular. The inner distal angle of the stalk is much less rounded than the outer. The anterior margin is very slightly concave. The eye-speck or cornea is situated on the side just behind the rounded portion of the angle. The three teeth of the front extend forward to nearly the same line, the rostral tooth is, however, a trifle shorter. The sinus behind the eye is divided by a lobe into two nearly equal parts.

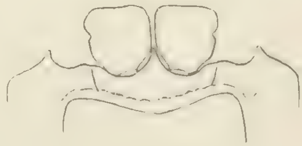


FIG. 7.—LEPIDOPA MEARNSI, × 4.

This species is more nearly related to *L. richmondi* than to any other. It is represented by one specimen in very bad condition, the front and eye stalks are, however, intact.

The unique type-specimen is labeled "West coast of Central America."

Type.—No. 26171, U.S.N.M.

LEPIDOPA RICHMONDI, new species.

The character of the eyes is almost identical with *L. mearnsi*, except that the eyes of this species are proportionally slightly smaller, the distal margin is more nearly straight and the inner margin is slightly more arcuate. The median projection of the front is a little posterior to the line of the projection of the teeth; this alters the character of the sinus behind the eye and eliminates the slight sinus found behind the antennula in *L. mearnsi*. The margin between the ocular sinus and the lateral tooth of the front is transverse. At first sight the effect of the lateral tooth rising beyond the margin is to give it the appearance of a double sinus as in *L. mearnsi*, but a careful examination shows that this is erroneous, except in the manner that a sinus always exists at the side of a spine or tooth-like projection. The carapace is arcuate but slightly flattened on the sides, forming a low ridge on the median line. Longitudinally the carapace is straight. The flagellum of the *richmondi* has 8 joints.

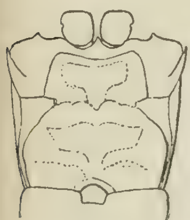


FIG. 8.—LEPIDOPA RICHMONDI, × 2½.

Distance between lateral points of the front is 5 mm. Size of eye scales is 1.5 mm. by 1.5 mm.

Locality.—A single specimen from Greytown, Nicaragua, collected by Dr. C. W. Richmond, for whom it is named.

Type.—No. 25828, U.S.N.M.

A REVIEW OF THE SILUROID FISHES OR CATFISHES OF JAPAN.

By David Starr Jordan and Henry W. Fowler,

Of the Leland Stanford Junior University.

In the present paper is given a review of the catfishes or *Nematognathi* known to inhabit the waters of Japan. The paper is based on the collections made by Messrs. Jordan and Snyder in 1900, a series of these specimens being placed in the U. S. National Museum.

Order NEMATOGNATHI.

CATFISHES.

Parietals and supraoccipital confluent. Four anterior vertebræ coossified, and with ossicula auditus or weberian apparatus. No mesopterygium. Basis cranii and pterotic bone simple; no coronoid bone. Third superior pharyngeal bone wanting, or small and resting on the fourth; second directed backward. One or 2 pairs of basal branchihyals; 2 pairs of branchihyals. Suboperculum wanting, or modified into the uppermost branchiostegal. Mesocoracoid present. Premaxillary forming border of mouth above, except in one family (*Diplomystidæ*), in which the maxillaries also bear teeth. Interclavicles present. No scales. Skin naked or with bony plates.

This group comprises 2 families, *Plotosidæ* and *Siluridæ* among Japanese fishes.

(*νῆμα*, thread; *γνάθος*, jaw; from the maxillary barbels which are always present.)

a. Air bladder well developed, usually simple or with transverse constructions, lying free in the abdominal cavity. Mouth terminal, teeth villiform, conical, incisor or molarlike; intestines short, arranged in longitudinal folds; body naked, or with 1 series of lateral plates; diaphragm membranous; tip of scapular process reaching basioccipital.

b. Dorsal and anal nearly coextensive with the caudal portion of the vertebral column; the first dorsal short, the second not adipose, united to the caudal; opercle present.

c. Gill membranes not confluent with the isthmus, or united only by a very narrow strip; gill-openings broad; 2 dorsals, the first short and with spine in front; second dorsal long and joined to caudal; anal united with caudal; no adipose dorsal; ventrals many-rayed; air-bladder not inclosed in bone. Plotosidæ, 1.

bb. Dorsal short or wanting; confined to the abdominal portion of the vertebral column.

d. Opercle well developed and movable; adipose fin normally present; gill-openings usually wide; caudal vertebræ not compressed, the neural spines simple, spine-like.

dd. Maxillary reduced to a rudiment, the intermaxillaries only forming margin of upper jaw .... SILURIDÆ, 2.

Family I. PLOTOSIDÆ.

Body more or less elongate and naked. Front of head with at least 8 barbels. Gill-openings wide and the gill-membranes not confluent with the isthmus, or only narrowly united. Dorsals 2, the first short and with a spine in front, the second long and joined to the caudal; anal long and confluent with caudal. No adipose dorsal. Opercle present. A dentritic post-anal organ. Air-bladder not inclosed in bone.

Sea catfishes, often reaching a large size, and confined to the warm and tropical coasts of the Indian Ocean, the seas about the East Indies, and Australia, one species extending its range eastward to Samoa.

1. PLOTOSUS Lacépède.

Plotosus LACÉPÈDE, Hist. Nat. Poiss., V, 1803, p. 130 (*anguillaris*).

Body elongate, thick in front, and the tail tapering. Head depressed and covered with thin skin; snout rounded in front; eyes small; mouth transverse; jaws with 8 barbels; conical teeth in upper jaw, those on the mandible mixed, and vomer with molar-like teeth; nostrils far apart, the anterior tubular; 9 to 12 branchiostegals. Gill-openings wide, the gill-membranes not joined to the isthmus. Dorsals 2, the first short, few-rayed, and with a spine in front, and the second very long, many-rayed and like the anal, confluent with caudal; pectoral spines developed; ventrals with as many as 12 rays. Air vessel moderate in size and not inclosed in bone. A dendritic post-anal organ. East Indian Seas, from Africa and India to Japan.

(πλωτός, floating.)

1. PLOTOSUS ANGUILLARIS (Lacépède).

GIGI (CATFISH), SHIMAGIN (STRIPED CATFISH), UMIGIGI (SEA CATFISH.)

Plotosus anguillaris LACÉPÈDE, Hist. Nat. Poiss., V, 1803, p. 130, pl. III, fig. 2; "Les Grandes Indes."—RÜPPELL, Fische, Neue Wirbelthiere, 1837, p. 76; Red Sea.—CANTOR, Catal. Malay. Fish., 1850, p. 264; Malayan Peninsula.—BLEEKER, Ichthy. Archipel. Ind. Prodrom. Siluroid, 1858, p. 314.—GÜNTHER, Cat. Fish., V, 1864, p. 24; Pinang, Sumatra, Borneo, Amoy, Philippines, Fiji, Marston Bay.—STEINDACHNER and DÖDERLEIN, Fische Japans, IV, 1887, p. 287; Tokyo, Enoshima, Inland Sea, and Kagoshima.—ISHIKAWA, Prel. Cat., 1897, p. 24; Tokyo, Izu.

Plotosus lineatus Cuvier and Valenciennes, Hist. Nat. Poiss., XV, 1840, p. 412; Red Sea, Seychelles, Malabar, Ile de France, Trinquemalo, Pondicherry, Amboina, Celebes, Friendly Islands, Tahiti, Macao, Philippines.—Richardson, Ichth. China, 1846, p. 286; Canton.—Schlegel, Fauna Japonica Poiss.,[a] 1846, p. 228, pl. civ, fig. 3; Nagasaki.—Bleeker, Verhand. Batav. Genootsch., XXI, 1858, pp. 4, 17, 57.

Plotosus arab[b] Bleeker, Atlas Ichth., II, 1862, p. 98, pl. xcv, fig. 2 (several figures), founded on "36 (Silurus) (d) Arab *Boa* vel *Buja*" of Forskål Descript. Animal., 1775, p. XVI.—Day, Fishes India, I, 1878–88, p. 483, pl. cxii, fig. 4.—Day, Fauna Brit. Ind., I, 1889, p. (XI) 113.—Kner, Novara, Fische, 1865–67, p. 300.—Day, Fishes, Malabar, 1865, p. 195.—Klunzinger, Verhand. Zool. Botan. Gesellsch., 1871, p. 588.—Jordan and Snyder, Proc. U. S. Nat. Mus., XXIII, 1900, p. 340; Tokyo.—Jordan and Snyder, Annot. Zool. Japan, III, April 3, 1901, p. 44; Yokohama.

Head $3\frac{7}{8}$ in length; depth $5\frac{3}{4}$; D. I, 5–80; A. 68; P. I, 10; V. 12; width of head about $1\frac{1}{2}$ in its length; eye $2\frac{1}{2}$ in interorbital space, 3 in snout, $7\frac{1}{2}$ in head; pectoral 2 in head; ventral $2\frac{1}{3}$.

Body elongate, the trunk thickest in front, compressed laterally, and the tail rather long and tapering. Head large, broad, depressed; when seen from above, the snout is broadly rounded and flattened; eyes small, anterior and superior; mouth very broad; upper jaw produced; teeth in the jaws rather few, large, coarse, with blunt ends, and similarly formed on the vomer and palatines; lips rather thick, fleshy and with small laminated folds or papillæ; 8 barbels, more or less equal, and distributed as 2 nasals, 2 maxillaries, and 4 mentals, the longest not equal to half the head; interorbital space concave and broad. Gill-openings large, and forming a fold over the broad isthmus. Gill-rakers numerous and slender; no pseudobranchiæ.

Body perfectly smooth and naked.

First dorsal high, its base less than the interorbital space, the spine strong, a little more than half the height of the fin, and the anterior edge serrate above; second dorsal long, of uniform height, and beginning between the origin of the ventrals and that of the anal; anal similar to second dorsal, and both joined to the caudal, which is rounded behind; pectorals equal to first dorsal, the spine similar to that of the first dorsal, more than half the length of the fin, and with its outer edge serrate; when depressed the pectorals do not reach quite to the ventrals, though these reach past the anal. The lateral line is well developed. A well-developed dendritic post-anal organ.

[a] We are indebted to Mr. Edgar R. Waite, of the Australian Museum, for the dates of publication of the different parts of the Fauna Japonica. These are as follows: Decade I, pp. 1–20, 1842; Decades II, III, IV, pp. 21–72, 1843; Decades V, VI, pp. 73–112, 1844; Decades VII, VIII, IX, pp. 113–172, 1845; Decades X to XIV, pp. 173–269, 1846; Decade XV, pp. 270–324, 1850.

[b] The specific name *arab* adopted by Bleeker from Forshål was an abbreviated form of the word *Arabic* or its Latin equivalent, and should in no wise be construed as a scientific term.

Color in alcohol brown, pale on the abdomen and lower surface of the head; along the upper portion of the sides, a narrow pale line from snout above eye to near base of caudal above, and from below eye another similar narrow stripe below lateral line and persisting to the posterior portion of tail; edges of second dorsal, caudal and anal blackish.

Length $8\frac{1}{4}$ inches.

This description is taken from a specimen from Misaki. The species is found through the shore waters of east Africa, Red Sea, southern Asia, the East Indies to Polynesia and Japan.

Our many specimens from Tokyo, Misaki, Wakanoura, Mogi, and Nagasaki.

This species is very abundant along the shores of shallow sandy bays throughout southern Japan. It rarely exceeds a foot in length. It is not much value as food, and its sharp spines cause it to be detested by the fishermen. Great numbers are taken in the shallow bay of Mogi near Nagasaki.

(*anguillaris*, eel-like.)

Family II. SILURIDÆ.

Body more or less elongate, naked or covered with bony plates. No true scales. Anterior part of head with 2 or more barbels, the base of the longest pair formed by the small or rudimentary maxillary. Margin of upper jaw formed by premaxillaries only. Suboperculum absent; operculum present. Dorsal fin usually present, short, above, or in front of the ventrals. An adipose fin usually present. Anterior rays or dorsal and pectorals usually spinous. Air bladder usually present, large, and connected with the organ of hearing by means of the auditory ossicles. Lower pharyngeals separate. Species numerous, mostly in fresh waters, the large subfamily of *Ariinæ* confined to the sea. None of these occur in Japan proper.

a. Gill membranes free or forming a free fold across the isthmus, rarely joined to it; anal fin shorter than caudal portion of vertebral column.
- *b.* ARIINÆ. Nostrils close together, neither with a barbel, the posterior with a valve; teeth on the palate; caudal forked (species chiefly marine).
  - *c.* Lower jaw with 4 barbels; palatine teeth fixed; both jaws with teeth above; gill-rakers few, 5 to 25; eyes above level of the mouth....... *Tachysurus*, 2.
- *bb.* Nostrils remote from each other.
  - *d.* SILURINÆ. Dorsal and adipose fins very short, if present; anal very long; ventrals below or placed behind dorsals; gill membranes entirely separate.
    - *e.* Eye situated above the level of the angle of the mouth; caudal rounded; adipose fin none; barbels four; spinous dorsal small.... *Parasilurus*, 3.
  - *dd.* BAGRINÆ. Dorsal fin short, placed anteriorly on the trunk, in advance of ventrals; adipose fin well developed, sometimes short; anal short, or of moderate length; gill membranes not confluent with the skin of the isthmus, with free posterior margin.

f. Adipose fin not adnate, free behind, as in *Ameiurus;* mental barbels as usual, the median pair not notably distant.

g. Anal rays 20 to 25.

h. Caudal fin deeply forked; upper surface of head bony and granulated, the skin covering the bones being very thin.. *Fluvidraco*, 4.

hh. Caudal fin subtruncate; upper surface of head covered with thick smooth skin, concealing the bones .... *Pseudobagrus*, 5.

gg. Anal rays 14 to 17; eyes very small; head covered with soft skin; caudal deeply forked.............................. *Leiocassis*, 6.

ff. Adipose fin adnate to the back and connected with the caudal; caudal rounded; median mental barbals far apart; body elongate; head small, smooth above; dorsal well forward............*Liobagrus*, 7.

2. TACHYSURUS Lacépède.

Tachysurus LACÉPÈDE, Hist. Nat. Poiss., 1803, p. 151, pl. v, fig. 2 (*Sinensis*).

Arius[a] CUVIER and VALENCIENNES, Hist. Nat. Poiss., XV, 1840, p. 52, in part, not the "chef de file" or type (*grandicassis*, *arius*, etc.; restricted to *Pimelodus arius* by Bleeker in 1858 = *Tachysurus*).

Ariodes MÜLLER and TROSCHEL, Horæ Ichthyol., III, 1849, p. 9 (*arenarius*, etc.) (= *Tachysurus*).

Pseudarius BLEEKER, Ichth. Archipel. Indi. Prodrom. Siluroid., 1858, p. 91 (*Pimelodus arius; grandicassis* being regarded as type of *Arius.*)

Body more or less elongate, subterete. Head armed with a bony shield above, behind which projects an occipital shield, another smaller crescent-shaped shield at the base of the dorsal spine, these processes and bones exposed or covered with very thin skin, and the bones on top of the head together with the occipital process granular; skull with a fontanelle; eyes with a more or less free orbital margin; mouth not large, the upper jaw the longer; teeth in jaws villiform, more or less granular, in a band in each jaw; palatine patches of teeth granular, without a backward projecting angle on the inner margin, and never movable; barbels 6 (no nasal barbels), close together, the posterior with a valve; maxillary barbels usually short and terete or somewhat compressed. Gill membranes not forming a free margin across the isthmus. Skin smooth, naked, except on the head above. Dorsal fin short, in front of ventrals with a pungent spine; adipose fin well developed, posteriorly free; caudal fin deeply forked; anal fin short; pectorals each with a spine; ventral rays six. General color brown with blue reflections.

Marine catfishes. The species abundant on sandy shores in the tropical seas, never about coral reefs. None of them occur in Japan proper.

(ταχύς, swift; οὐρά, tail.)

[a] The generic name *Arius* may, however, properly be retained for *Arius grandicassis*, Valenciennes's "chef de file" or type, thus replacing *Netuma*, although the name *Arius* is derived from an Indian name *Ari*.

2. TACHYSURUS MACULATUS (Thunberg).

Silurus maculatus Thunberg, Vet. Acad. Nya. Handl., XIII, 1792, p. 31, pl. I, fig. 1; Japan.

Arius maculatus Günther, Cat. Fish. Brit. Mus., V, 1864, p. 166.

Tachysurus maculatus Jordan and Snyder, Annot. Zool. Japan, III, April 3, 1901, p. 45; no locality.

Silurus ocellatus Bloch and Schneider, Syst. Ichth., 1801, p. 379 (after Thunberg).

Arius ocellatus Cuvier and Valenciennes, Hist. Nat. Poiss., XV, 1840, p. 104 (after Bloch and Schneider).

Arius ocellatus Bleeker, Verhandl. Batavia, Genootsch. Kunst. Wetensch., XV, 1853, pp. 30 and 51.

Pimelodus arius Hamilton-Buchanan, Fishes of Ganges, pp. 170, 376; Bengal.

Arius arius Cuvier and Valenciennes, Hist. Nat. Poiss., XV, 1840, p. 102; Pondicherry.

Arius gagorides Bleeker, Verh. Bat. Gen., XXI, Silur., p. 42; East Indies.

Arius chondropterygioides Bleeker, Verh. Bat. Gen., XXI, Silur., p. 44; East Indies.

Arius angulatus Bleeker, Verh. Bat. Gen., XXI, Silur., p. 44; East Indies.

Arius heckeli Bleeker, Verh. Bat. Gen., XXI, Silur., p. 44; East Indies.

Pseudarius borneensis Bleeker, Atl. Ichthy. Silur., p. 36, pl. XIX; Borneo.

Head $3\frac{2}{5}$ to $3\frac{1}{4}$ in length; depth $4\frac{2}{3}$ to 5; D. I, 7; A., 20 to 22; P. I, 10. Head rather broader than high, its greatest width $\frac{2}{3}$ to $\frac{3}{4}$ its length; band of intermaxillary teeth is six times as long as broad; teeth on the palate granular, in two separate semiovate patches; maxillary barbels considerably shorter than the head; occipital process granulated, subtriangular, scarcely longer than broad. Dorsal fin higher than body; its spine strong, serrated along both edges, and it is contained $1\frac{1}{5}$ to $1\frac{2}{3}$ in the head; adipose fin rather shorter than dorsal; pectoral $\frac{2}{3}$ to $\frac{3}{5}$ the length of the head, and its spine nearly as long as that of the dorsal fin. Adipose fin with a large black spot. (Günther.)

East Indies and China, only known from Japan in the record of Thunberg, which was probably made at Miyako Island in the Riukiu archipelago.

The synonymy above given is compiled from authors and needs verification.

(*maculatus*, spotted.)

3. PARASILURUS Bleeker.

Glanis Agassiz, Proc. Amer. Acad., 1856, p. 333 (*aristotelis*). (Name preoccupied by *Glanis* Gronow, 1854.)

Parasilurus Bleeker, Nederl. Tydschr. Dierk., 1863, p. 114 (*asotus*).

Body elongate, the profile of the back almost horizontal. Head depressed and covered with soft skin; eyes anterior and subcutaneous; mouth broad, transverse; barbels 4, two very long maxillaries and 2 short mentals; teeth cardiform or villiform, in broad bands in the

jaws and on vomer; no teeth on palatines. Gill opening wide, not confluent with the isthmus, and narrowly joined together. Dorsal small, without spine, and anterior; adipose fin absent; anal more or less united with the caudal, very long; pectorals with spine; ventrals behind dorsal. Air bladder not inclosed in bone. Fresh-water Siluroids found in India, East Indies, China, and Japan.

This genus is very close to *Silurus* and distinguished chiefly by the number of barbels, which are 6 in that genus. The preoccupied name *Glanis*, based on the species of this genus found in Greece (*Glanis aristotelis*), is, as Garman has shown, a synonym of the later *Parasilurus*.

(παρά, near; *Silurus*.)

3. PARASILURUS ASOTUS (Linnæus).

NAMAZU (MUD-FISH).

Silurus asotus LINNÆUS, Syst. Nat., 10th ed., 1758, p. 501; Asia.—BLOCH and SCHNEIDER, Syst. Ichth., 1801, p. 378.—BASILEWSKY, Nouv. Mém. Soc. Nat. Mos., X, 1855, p. 240, pl. III, fig. 4; Pechili, China.—GÜNTHER, Cat. Fish. Brit. Mus., V, 1864, p. 33; Japan, China.—ISHIKAWA, Prel. Cat., 1897, p. 23; Tokyo, Suwa, Mino, Hikone.

Silurus japonicus SCHLEGEL, Fauna Japonica, Pisc., 1846, p. 226, pl. CIV, fig. 1; Higo, Satsuma, Nagasaki.—BLEEKER, Verhandel. Batavia Genootsch. Kunst. Wetensch., XXV, 1853, pp. 30 and 51.

Silurus asotus STEINDACHNER and DODERLEIN, Denk. Akad. Wissensch., LIII, 1887, p. 287; Tokyo.—SAUVAGE, Bull. Soc. Philomat. (Paris) 1883, p. 2; Lake Biwa.

Parasilurus asotus JORDAN and SNYDER, Check List, p. 45; Yokohama, Lake Biwa.

Head $4\frac{3}{5}$ in length; depth $5\frac{5}{8}$; D. 6; A. 78; P. I, 13; V. 12; width of head two-thirds its length; eye about 9 in head; $2\frac{1}{2}$ in snout; 5 in interorbital space; pectoral $1\frac{3}{4}$ in head; ventral $2\frac{1}{4}$.

Body elongate, the trunk deepest in front, compressed laterally, and the tail long and tapering. Head moderate, broadly depressed; when viewed from above the snout is broadly rounded and flattened; eyes small, lateral, and anterior; mouth very broad and superior, the mandible projecting; teeth sharp, in broad villiform bands in the jaws and on vomer and palatines; lips rather thin and smooth; nostrils rather far apart, the anterior in a small tube; barbels 4, 2 very long maxillaries and 2 short mentals; interorbital space very broad, elevated, and flattened in the middle. Gill openings large, very narrowly jointed, and separate from the very broad isthmus. Gill-rakers few and rather short; no pseudobranchiæ.

Body perfectly smooth and naked.

Dorsal a little shorter than the ventral and inserted just before the tip of the pectoral; anal very long, united with the caudal behind, of uniform height, and its origin much before the middle of the length; pectoral spine stout, both edges with strong denticulations, and about

three-fifths the length of the fin; pectorals not reaching the ventrals, which are shorter and reach beyond the origin of the anal; tail slightly emarginate, the lobes distinctly rounded and the upper projecting a little.

Lateral line present. Anal papilla present.

Color, in alcohol, brown, the middle of the back darker; lower surface of the head and the abdomen whitish.

Length $10\frac{1}{2}$ inches.

This description from a specimen from Tokyo, collected by K. Otaki.

China and Japan, our specimens from Tokyo, collected by K. Otaki, Nügata, Morioka, Tana River, Kawatana, Sendai, Ichinoseki, Chikugo River at Kurume, Tsuchiura, Lake Biwa at Matsubara, and Formosa.

This large catfish is very common in all the streams of middle and southern Japan, reaching a length of 2 or 3 feet. It is largely used as food. The Japanese species (*Parasilurus japonicus*) is considered by authors, doubtless correctly, as identical with *Parasilurus asotus*, a species widely distributed in eastern Asia.

(*asotus*, a sot.)

4. FLUVIDRACO Jordan and Fowler.

Fluvidraco Jordan and Fowler, new genus (*ransonnetii*).

This genus is close to *Pseudobagrus*, differing in the deeply forked caudal and in having the top of the head rough and granulated, the covering skin being very thin. Rivers of Japan and China. The "Yellow Dragon" of Canton, *Fluvidraco fulvidraco* (Richardson), seems to belong to this genus.

(*fluvius*, river; *draco*, dragon.)

a. Outer edge of pectoral spine without serrations; bony occipital bridge and humeral processes granulate and covered with thin skin; anal rays 20..*ransonneti*, 4.

aa. Pectoral spine strongly serrated (along both edges?); head granulated above; anal rays 23 ....*nudiceps*, 5.

4. FLUVIDRACO RANSONNETII (Steindachner).

Pseudobagrus ransonnetii Steindachner, Fische Japans, IV, 1887, p. 287; Osaka.—Jordan and Snyder, Annot. Zool. Japan, III, 1901, p. 44.

Pseudobagrus fulvidraco Ishikawa, Prel. Cat., 1897, p. 23 (not of Richardson); Lake Biwa, Hikone, Yamashiro, Tosa; Katsuura R.

Head $4\frac{1}{4}$ in length; depth 6; D. I, 7; A. 20; P. I, 7; V. 6; width of head $1\frac{1}{5}$ in its length; eye 5 in head; $1\frac{1}{2}$ in snout; $2\frac{1}{4}$ in interorbital space; pectoral $1\frac{1}{3}$; ventral a little more than half the head.

Body elongate, compressed. Head broad, depressed; snout broad, obtuse, depressed, and flattened above; eye moderate, anterior lateral, and more or less covered with the skin of the head; mouth very broad, transverse, and its width about $2\frac{2}{3}$ in the head; teeth in broad villiform bands in the jaws, and the roof of the mouth also with a broad trans-

verse band; 8 barbels, the nasals and median mentals about equal, shorter than the outer mentals: which are not as long as the maxillaries, the latter reaching beyond the gill-openings, and all of the mentals rather evenly distributed; lips moderately thick; interorbital space broad, flattened, and very slightly elevated; anterior nostrils tubular and in a shallow depression. Gill openings large, the membrane deeply notched and forming a free fold across the isthmus; the isthmus broad. Gill-rakers narrow, 3+9.

Body smooth, top of the head smooth, the occipital process and the plate in front of the spinous dorsal finely striate or granular; humeral process finely granular.

Origin of dorsal in advance of tip of pectoral spine, its spine long, sharp, smooth, and shorter than the longest rays; base of anal long, and its origin nearer the posterior margin of eye than tip of caudal; caudal shorter than head, deeply forked, the lobes somewhat pointed, and the

FIG. 1.—FLUVIDRACO RANSONNETII.

upper the longer; pectoral equal to head without snout, the spine smooth, except along its posterior edge, which is armed with strong recurved teeth; ventrals broad and reaching origin of anal; adipose fin long, though less than the base of the anal, and its posterior edge not adnate and not extending beyond posterior tip of anal, its form much as in Ameiurus. Anal papilla developed. Lateral line present.

Color brown, darker above, the abdomen and lower surface of the head pale or whitish; the edges of the dorsal, anal, caudal, pectorals, and ventrals broadly blackish.

Length $5\frac{3}{4}$ inches.

Rivers of Japan, common southward. Our specimens are from Waka River, near Wakanoura, Tsuruga, Matsubara on Lake Biwa, Lake Yogo in Mino, the Yodo River in Osaka, and Nagoya in Owari, the last from the collection of K. Otaki.

(Named for Baron Ransonnet, who obtained the species at Osaka.)

5. FLUVIDRACO NUDICEPS (Sauvage).

Pseudobagrus nudiceps SAUVAGE, Bull. Soc. Philomat., 1883, p. 2; Lake Biwa.

The original description is as follows:

D. I, 6; A. 23; P. I, 7. Longueur de la tête contenue cinq fois dans la longueur totale; dessus de la tête osseux, granuleux; processus occipital plus long que large, étroit; os basilaire triangulaire, aussi long que le processus occipital, partagé par une suture transverse. Dorsale plus haute que le corps; épine dentelée, aussi longue que la tête, sans le museau. Épine pectorale la même longueur que l'épine dorsale, de même longueur que celle-ci, très fortement dentelée. Adipeuse de même longueur que l'anale. Dents du palais suivant une bande rétrécie au milieu; barbillons maxillaires s'étendant jusqu'aux pectorales. Longueur, 0,090.

This species is near *Fluvidraco fulvidraco* (Richardson), of the streams of Canton. It is also near *Fluvidraco ransonnetii*, and may even be the same. There is no evidence that *Fluvidraco fulvidraco* occurs in Japan.

(*nudus*, naked; *ceps*, head.)

5. PSEUDOBAGRUS Bleeker.

Pseudobagrus BLEEKER, Act. Soc. Sci. Indo-Nederl., VII, 1860, p. 87 (*aurantiacus*).

Body moderately elongate. Head broad and depressed, covered above by moderately thick, smooth skin; eyes moderate or rather small; snout broad, obtuse; mouth broad, transverse, and with bands of villiform teeth in the jaws; a continuous transverse band of teeth on the roof of the mouth; nostrils remote, the anterior usually in a small tube; 8 barbels, the maxillaries the longest, and the mentals more or less evenly distributed. Dorsal fin short, with 5 to 7 rays, and like the pectoral with a stout spine; caudal rounded or subtruncate; anal with 20 or more radii; ventrals broad, with 6 rays.

(ψεύδης false; *Bagrus*).

6. PSEUDOBAGRUS AURANTIACUS (Schlegel).

GIGI; GIBACHI.

Bagrus aurantiacus SCHLEGEL, Fauna Japonica, 1846, p. 227, pl. CIV, fig. 2; Satsuma, Kuruma, Higo.

Pseudobagrus aurantiacus BLEEKER, Act. Soc. Sci. Indo-Nederl., VII, p. 85.—GÜNTHER, Cat. Fish. Brit. Mus., V, 1864, p. 85.—SAUVAGE, Bull. Soc. Philomat., 1883, p. 2; Lake Biwa.—JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1900, p. 340; Tokyo; Annot. Zool. Japan, III, April 3, 1901, p. 44.—ISHIKAWA, Prel. Cat., 1897, p. 22; Tokyo, Chichibu, Suwa, Tega Lake.

Pseudobagrus tokiensis DÖDERLEIN, Fische Japans, IV, 1887, p. 288; Tokyo.—JORDAN and SNYDER, Annot. Zool. Japan, II, April 3, 1901, p. 45.

Head, $5\frac{1}{5}$ in length; depth, 7; D. I, 7; A., 20; P. I., 7; V., 6; eye, $1\frac{1}{2}$ in interorbital space; width of mouth, 2 in head; pectoral, $1\frac{1}{2}$ in head; ventral, 2.

Body elongate, with rather uniform depth, the tail strongly compressed. Head broad, depressed; snout short, bluntly rounded when viewed from above and projecting beyond the mandible; the width of the head is less than its length; eyes small, laterally superior, and cov-

ered with thin skin; jaws with broad bands of villiform teeth, also on the palate in a broad transverse band; lips moderately thick and slightly papillose; nasal and median mental barbels about equal, about half the length of the maxillary pair, which latter are much longer than the outer mentals, though considerably shorter than the length of the head; the mental barbels are all rather evenly distributed, the median pair slightly farther apart than either is from the outer, the interorbital space is broad, elevated, and flattened; anterior nostrils tubular and in a shallow pit. Gill openings large, the gill membrane deeply notched and forming a free fold across the isthmus; isthmus broad. Gill rakers narrow, 3+7.

Body smooth; top of the head smooth; humeral process finely granular.

Origin of dorsal, above the tip of pectoral, its spine sharp and half the length of the dorsal; anal base rather long; caudal truncate, its edge rounded, very slightly emarginate, and with the two lobes rounded, the upper slightly the longer; adipose dorsal much shorter than anal and ending before tip of anal; pectoral with robust roughened spine, the inner edge with large teeth, falling short of the end of the fin; ventral broad, behind dorsal and reaching almost to the origin of the anal. Anal papilla well developed. Lateral line well developed and superior in front; head with a number of pores.

Color brown, dark above, clouded with deep brown, the abdomen and lower surface of the head pale or whitish.

Total length 9½ inches.

This description from our largest specimen taken in the Kitakami River.

This species is abundant in the streams throughout most of the islands of Japan, our specimens from Tokyo, Kinu River at Utsunomiya, Tana River at Tachikawa, Tsuchiura, and Kitakami River at Morioka. It is often spitted on sticks, roasted, and sold cold in the shops and eating houses. It rarely exceeds a foot in length. The *Pseudobagrus tokiensis* of Döderlein seems to be identical with this species, as the main characters in which it was supposed to differ do not seem to be tangible.

(*aurantiacus*, orange-colored.)

6. LEIOCASSIS Bleeker.

Leiocassis BLEEKER, Ichthy. Archipel. Indi. Prodrom. Siluroid, 1858, p. 139 (*poecilopterus*).

The upper jaw the longer; eyes below the skin; no free circular fold round the orbit; no movable labial teeth; teeth on the palate in a continuous band; barbels 8. Dorsal short, with 7 rays, with denticulated pungent spine, the teeth not projecting upward; anal short, with less than 20 rays; caudal forked; ventral with six rays. East Indies and Japan.

(λεῖος, smooth; κάσσις, casque.)

7. LEIOCASSIS LONGIROSTRIS (Günther).

Liocassis longirostris GÜNTHER, Cat. Fish, V, 1864, p. 87; Japan.
Leiocassis longirostris JORDAN and SNYDER, Annot. Zool. Japan, III, April 3, 1901, p. 44; Japan.

Head $3\frac{3}{4}$ in length; depth 5; D. I, 7; A. 17; P. I, 9; V, 6; B. 8; interorbital space 2 in snout; more than 3 in head, least depth of tail a little more than $\frac{1}{2}$.

Trunk slightly compressed, the tail elongate, tapering. Head as high as broad, with the crown compressed, the sides obliquely sloping outward; snout much produced and conical, so that the mouth is about midway between the eye and end of the snout; eyes very small, without free circular eyelid, and much nearer the extremity of the snout than the end of the operculum; cleft of the mouth transverse, entirely at the lower side of the snout; teeth villiform, in broad bands, the intermaxillary band 4 times as broad as long, and the vomerine band, which is immediately behind, nearly as broad and long as the former; the posterior nostril nearer to the eye than to the extremity of the snout, and its barbel is slender, not much longer than the eye; the anterior nostril is in the upper lip in front of the maxillary barbel; maxillary and mandibular barbels small; upper side of the head only slightly granulated, the median fonticulus does not extend to the base of the occipital process, the latter finely granulated, arrow-shaped, twice as long as broad, and below the skin it extends on to the basal bone of the dorsal spine, which is elongate, triangular, and finely granulated; a skinny space between the basal bone and the granulated part of the occipital process; opercles covered with skin. The gill-membranes are separate nearly to the front of the isthmus.

Dorsal spine strong, not much shorter than the head; its serrature behind does not point either downward or upward, but is vertical to the spine, and as long as and terminates in the same vertical with the adipose fin; caudal deeply forked; pectoral spine somewhat stronger and shorter than that of the dorsal fin; the ventrals extend somewhat beyond the origin of the anal. The free portion of the tail between adipose and caudal fin equals the base of the adipose fin, and is a little less than $\frac{1}{5}$ the total (without caudal). Humeral process of moderate size, pointed behind; mucous cavity in the axil with 2 foramina. Length 23 inches.

Japan; collection of Mr. Jamrach. (Günther.)

This species was not seen by us, and may possibly not be really Japanese.

(*longus*, long; *rostrum*, snout).

7. LIOBAGRUS Hilgendorf.

Liobagrus[a] HILGENDORF, Sitzungs. Gesellsch. naturforsch. Freund., Berlin, 1878, p. 1 (*reinii*).

Body elongate with compressed tail and rounded caudal. Head broad and depressed; top of head smooth, and the humeral process smooth; eyes small and covered with thin skin, anterior in position; snout broad, obtuse, and projecting; teeth only in jaws, in broad villiform bands, and those on the mandible divided; no teeth on palatines and vomer; barbels 8, the median mentals widely separated. Dorsal fin placed anteriorly; dorsal and pectoral spines smooth, sharp, and imbedded in the skin; adipose fin long and low, joined to the caudal as in *Noturus;* ventral fins small, not reaching the anal, which has 15 rays.

(λεῖος, smooth, *Bagrus*.)

8. LIOBAGRUS REINI Hilgendorf.

Liobagrus reinii HILGENDORF, Sitzungs. Gesellsch. naturforsch. Freund., Berlin, 1878, p. 1; Southern Japan.—SAUVAGE, Bull. Soc. Philomat., 1883, p. 2; Lake Biwa.—JORDAN and SNYDER, Annot. Zool., Japan, III, 1901, p. 44.

Gn.? Sp.? ISHIKAWA, Prel. Cat., 1897, p. 23, Nos. 414, 415, 416; Toshima, Iwashiro, Kii.

Head $4\frac{1}{2}$ in length; depth 8; D. I, 6; A. 15; P. I, 7; V. 6; width of head, $1\frac{1}{4}$ in its length; interorbital space 3 in head; eye 2 in interorbital space; caudal equal to head.

Body elongate, of rather uniform depth, and the tail strongly compressed. Head broad, depressed, with a more or less swollen appearance above; snout short, much less than the interorbital space, very broad and obtuse; eyes small, superiorly lateral, and covered with thin skin; mouth very broad, transverse, and about equal to half the length of the head; lips moderate, the upper jaw projecting; teeth in a single broad villiform band in the upper jaw, and in 2 narrowly

[a] The diagnosis of this genus and species is as follows: "*Liobagrus* nov. gen., Familie *Siluridæ*, Gruppe *Bagrina*. Fettflosse lang, niedrig; Dorsalis kurz, mit I stechenden, ungesägten und 6 weichen Strahlen; Analis kurz; Caudalis abgerundet; Ventralis mit 6 Strahlen. Eight Bartfäden. Zähne nur im Zwischen—und Unterkiefer, als Flecken von Hechelzähnen auftretend, keine Vomer—und Gaumenzähne (darauf soll der Name hindeuten). Augen unter der Haut, ohne Falte darum. Kiemenhaut bis ganz nach vorn hin frei.—Unter den durch Fehlen der Gaunmenzähne verwandten asiatischen Bagrinengattungen ist *Acrochordonichthys* durch enge Kiemenöffnung, *Akysis* durch ausgeschnittene Schwanzflosse, *Olyra* durch mehr als 20 Analstrahlen, *Branchiosteus* durch hervorragenden Unterkiefer zu unterscheiden. Die amerikanischen Gattungen haben $\frac{8}{9}$ strahlige Bauchflossen. *Liobagrus Reinii* sp. n., Br. 15, D. $\frac{1}{6}$, A. 15, P. $\frac{1}{7}$, V. 6.—1 Exemplar, 9 cm. lang, von Prof. Rein im südlichen Japan aufgefunden. Mit den bisher bekannten japanischen Bagrinen, *Pseudobagrus aurantiacus* Schl. und *Liocassis longirostris* Gunth., nach Obigem sicher nicht identisch."

divided similar patches on the mandible; palatines and vomer toothless; 2 nasal barbels, 2 longer maxillaries, and 2 still longer outer mentals which are about equal to the length of the head; inner mental barbels far apart and much shorter than the maxillaries; interorbital space broad and more or less flattened. Gill openings large, rather inferior, and the membrane with a deep notch; isthmus broad; branchiostegals large.

Body naked and smooth; top of head smooth.

Dorsal beginning before the tip of the pectoral spine, a little nearer tip of snout than base of ventrals, its spine smooth, without serrations, and more than half the height of the fin; the adipose fin is long, low, ascending gradually till above and beyond the tip of the anal, and adnate to the caudal by means of the rudimentary rays of the latter; origin of anal a little nearer the tip of caudal than the tip of snout,

Fig. 2.—Liobagrus reini.

and well separated from the caudal; caudal truncately rounded; pectoral spine smooth, sharply pointed, slightly curved, and more than half the length of the fin, which is equal to the width of the head, ventrals small, beginning beyond tip of dorsal, a little longer than the pectoral spine, and not reaching the anal.

Length $3\frac{1}{8}$ inches.

This description from a specimen from Tsuyama.

Southern Japan, our specimens from Niigata in Echigo (collected by Eitaro Iijima); from Tsuyama and from Nagoya in Owari (collected by K. Otaki).

(Named for Dr. Rein, an eminent student of Japanese history.)

To the *Liobagrus reini* probably belongs a species described in manuscript by Dr. Ishikawa, under the vernacular name of *Akaza* (red thing).

The body comparatively short and thick. The head flattened, rather small, its width $3\frac{3}{4}$ in the total length of the body; its depth about $\frac{5}{6}$; its length $3\frac{1}{2}$. The spines stout; the pectoral spine straight, situated at $3\frac{1}{3}$ in the distance from the snout to the dorsal, and not serrated, and with a groove on the ventral side. The dorsal fin higher than long, its origin is midway between the anal and the snout, its

spine nearly as long as the longest dorsal ray. The number of anal rays 14. The upper jaw projecting. The humeral process short and sharp. Color: Nearly uniform reddish-brown, with numerous spots, the ventral surface lighter colored. [illegible] siluroid fish living under stones and rocks in rocky streams, attaining the length of 105 mm.

Found in different places in Hokkaido and in the Main Island; our specimens in the Museum are from Toshima in Hokkaido, and from Iwashiro, Owari, Kii, and from Mimasaku. (*Ishikawa*, MS.)

SUMMARY.

ORDER NEMATOGNATHI.

Family I. Plotosidæ.

1. Plotosus Lacépède.

1. *anguillaris* (Lacépède); Tokyo, Misaki, Wakanoura, Mogi, Nagasaki; in the sea.

Family II. Siluridæ.

2. *Tachysurus* Lacépède.

2. *maculatus* (Thunberg).

3. *Parasilurus* Bleecker.

3. *asotus* (Linnæus); Tokyo, Morioka, Niigata, Tana R., Kawatana, Sendai, Ichinoseki, Chikugo R., Tsuchiura, Lake Biwa, Formosa.

4. *Fluvidraco* Jordan and Fowler.

4. *ransonnetii* (Steindachner); Wakanoura, Tsuruga, Lake Biwa, Lake Yogo, Yodo R., Nagoya.

5. *nudiceps* (Sauvage).

5. *Pseudobagrus* Bleeker.

6. *aurantiacus* (Schlegel); Tokyo, Kinu R., Tana R., Tsuchiura, Kitakami R.

6. *Leiocassis* Bleeker.

7. *longirostris* Günther.

7. *Liobagrus* Hilgendorf.

8. *reini* Hilgendorf; Tsuyama, Niigata, Nagoya.

NOTICE OF A COLLECTION OF FISHES MADE BY H. H. BRIMLEY IN CANE RIVER AND BOLLINGS CREEK, NORTH CAROLINA, WITH A DESCRIPTION OF A NEW SPECIES OF NOTROPIS (N. BRIMLEYI).

By Barton A. Bean,

Assistant Curator, Division of Fishes.

In this paper is given a list of a few fishes from a little known locality, and a description of a new species belonging to the subgenus *Hydrophlox* Jordan. It differs from the related species either in form, size of eye, number of scales, or in color. On a whole it seems to be most closely allied to *Notropis coccogenis* (Cope), but has a much more elongate body, the depth being contained 5¼ times in the standard length, while in Cope's species it is contained 4¼ times. The description of the type, which is preserved in the National Museum, follows.

NOTROPIS BRIMLEYI, new species.

Body elongate, rounded, not compressed as in *N. coccogenis*, to which it seems most nearly allied; its depth is contained 5¼ times in the length to origin of middle caudal rays; mouth moderately oblique, large, the maxillary extending to line from front margin of pupil; interorbital space broad, its width exceeding diameter of eye; jaws about equal. The length of the head equals ¼ of the total length, not including caudal, and the diameter of the eye is contained 3¼ times in length of head, slightly exceeding the length of the snout.

Teeth, 2—4—4—2. D. 9; A. 9; scales, 5/43/3; eighteen rows of scales before dorsal.

Color.—Light green on back, top of head darker; lower parts silvery white; a dark dorsal stripe from head to tail; a plumbeous band from upper angle of gill cover to caudal, where it broadens and extends to top of caudal peduncle; a dark scapular band; upper parts with dark punctulations; scales with dark edges; anterior portion of dorsal and caudal plain, posterior parts black; other fins plain.

The type specimen measures 3¾ inches in length; 3¼ inches to origin of middle caudal rays. It was collected in Cane River, October 4,

1902. Two cotypes from the same locality measure $2\frac{3}{4}$ and $2\frac{1}{2}$ inches. Type No. 50601, U.S.N.M.

Other species collected are: *Notropis arge* (Cope), eleven examples, 2 to 4 inches long, Cane River, October 4.

Rhinichthys cataracta (Cuvier and Valenciennes), two specimens from Bollings Creek, October 3, 1902. H. H. Brimley and Franklin Sherman, jr.

Hybopsis kentuckiensis (Rafinesque), twenty-four specimens from Cane River.

Campostoma anomalum (Rafinesque), one small specimen from Cane River.

Catostomus commersonii (Lacépède), one very young example from Cane River.

Catostomus nigricans Le Sueur, one specimen from Cane River.

Percina caprodes (Rafinesque), one very fine example from Cane River.

Cottus ictalops (Rafinesque), nine specimens from 1 to $2\frac{1}{2}$ inches long, collected in Bollings Creek, October 3, 1902.

ON THE RELATIONS OF THE FISHES OF THE FAMILY LAMPRIDIDÆ OR OPAHS.

By Theodore Gill.
Associate in Zoology.

I.

Dr. Boulenger, in the third number of his suggestive and valuable Notes on the Classification of Teleostean Fishes, has published some novel ideas respecting the systematic position of the Opah. He has found the same number of bones in the scapular arch as in that of normal Acanthopterygians, but has homologized them differently from his predecessors. The "very large bone to which the pelvis is attached" is designated as an "infraclavicle" and homologized with a so-called infraclavicle of Hemibranchiate fishes. A comparatively small bone in serial relation with the actinosts or "pterygials" is identified as the homologue of the hypocoracoid or "coracoid" of ordinary Acanthopterygians. There would then be only three actinosts or "pterygials," and it is especially remarked that the foremost of these is "fused with" the hypercoracoid or "scapula." As a result of these identifications, Dr. Boulenger thinks that "all difficulties from the systematic point of view disappear at once" and that "the Opah must be regarded as more nearly allied to the Hemibranchii than to any other group of fishes with which we are as yet acquainted." Consequently the Opah is isolated not only as the representative of a distinct family (*Lamprididæ*), but an independent group (*Selenichthyes*) of a new suborder (*Catosteomi*), which includes also the *Hemibranchii* and *Lophobranchii*.

II.

The great respect and admiration I have for Dr. Boulenger's work has led me to consider very carefully the grounds for the determinations in question, but I find greater difficulty in accommodating myself to his views than in accepting those (or nearly those) of his predecessors. Among the latter was William Kitchen Parker, who in 1868 commented on the structure of the Opah in A Monograph of the Structure and Development of the Shoulder Girdle (p. 51). His identifications essentially correspond with those now to be given, although his meaning is somewhat obscured by the curious mode of expression to which he was addicted. At any rate, he writes that

"the coracoid [hypocoracoid] reaches to the basal line below," and it "seems very probably to have had originally some assistance from an interclavicular ossicle." Parker regarded the Opah and Dory as "most aberrant Scomberoids," with a tendency toward the Plectognathi.

The difficulties of the homologization of the shoulder girdle of

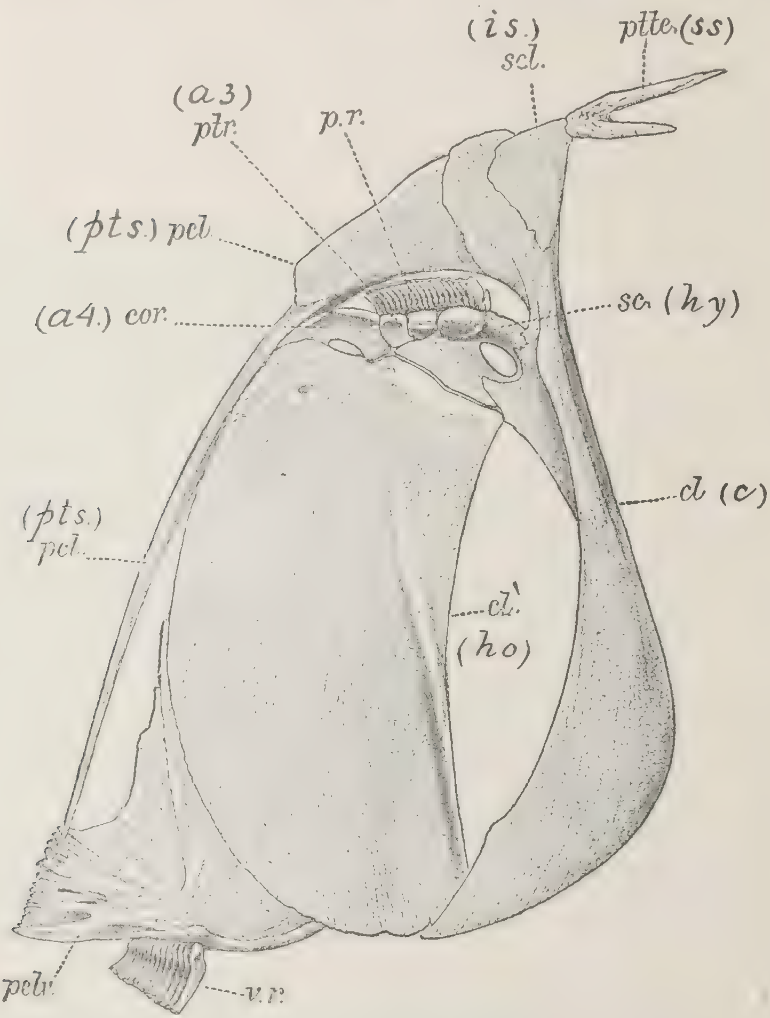


Fig. 1.—Shoulder girdle of Lampris guttata, outer view.

Gill.

c. suprascapula.
is. interscapula.
ps. cœnosteon or proscapula.
hy. hypercoracoid.
ho. hypocoracoid.
ac. actinosts 1–3.
a4. actinost 4.
pts. postscapula.
pelv. pelvis.
v.r. ventral rays.

Boulenger.

posttemporal (*ptte.*).
supraclavicle (*scl.*).
clavicle (*cl.*).
scapula (*sc.*)
infraclavicle (*cl.*).
pterygials (*ptr.*).
coracoid (*cor.*)
postclavicle (*pcl.*).
pelvis (*pelv.*).
ventral rays (*v.r.*).

Lampris may be made most evident and the explanation for other views best elucidated by the reproduction of Dr. Boulenger's excellent illustration of the shoulder girdle of the Opah. The names given are those which are preferred for the present, and the equivalents of Dr. Boulenger follow.[a]

With these identifications the structure of the Opah would be in conformity with that of most acanthopterygians, and the normal number of bones of the scapular arch would be realized.

The three main bones of the arch (cœnosteon, interscapula, and suprascapula) are developed essentially as usual, and as to them there is agreement with Dr. Boulenger except as to general morphological relations and nomenclature.

The actinosts or "pterygials," according to the present view of homologies, would also be realized. The almost universal number of four would thus be developed. There seems to me no more difficulty in considering that one actinost may be "synchondrosially united with the scapula" (or hypercoracoid) than that another should be coossified or "fused with" it. Consequently the complete number of actinosts (4) is recognized, although none is as slightly connected with the supporting bones as usual. Thus, also, the relative proportions of the various elements of the shoulder girdle and its appendages would be manifest approximately as in ordinary fishes.

III.

One objection against the homology of the hindmost (or lowermost) actinost of the Opah with an actinost is urged by Dr. Boulenger in the statement "that the posterior of the supposed pterygials [actinosts] does not support rays and is altogether unlike a pterygial."

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[a] It might be supposed by one unfamiliar with the intricacies of anatomical nomenclature, from the difference in the nomenclature of the bones, that the differences between Dr. Boulenger and myself are greater than they really are. The only extranominal differences relate to the two bones called coracoid and infraclavicle by Boulenger, and hypocoracoid and fourth actinost by myself. I am happy to know that the divergencies respecting the other names are simply the result of different interpretations of the same facts from a general standpoint. Dr. Boulenger is the orthodox party, inasmuch as he agrees with the majority of anatomists in accepting the nomenclature that has been most current (except in Great Britain) since the time of Gegenbaur. I have to confess to being the heterodox party. But a review of the paleontological and developmental history of the shoulder girdle, as well as of its comparative anatomy, compels me to reject a nomenclature which appears to me to be extremely misleading. The hypercoracoid and hypocoracoid are only developed in specialized teleost fishes and are (as well as the mesocoracoid) the results of the ossification and disintegration of a single cartilage occurring in primitive and ganoid fishes and inherited from the Selachians. The application of the names scapula and coracoid, originally given to mammalian parts, entails a very erroneous and distorted idea of their relations and history, if it is assumed that the words have any extrinsic meaning at all.

There is such great variety in the form of the fourth actinost (as well as others) in fishes that the objection urged apparently is not of very great importance. Even among the universally recognized constituents of the group of Hemibranchs there is great diversity and differences as important as those differentiating the Opah from other fishes exist between the Centriscids or Amphisilids on the one hand and the Gasterosteids and Aulorhynchids on the other.

The cases of exclusion of rays from the fourth actinost are rare, but by no means confined to the Lampridids. We need, indeed, only look to the Hemibranchs again to find parallel cases. In the genus *Aulorhynchus*, as shown by Mr. Starks in his excellent article on those fishes, recently published, the fourth actinost is represented as destitute of rays quite as much as that of *Lampris*, and that of the common Sticklebacks of the north is almost if not quite as much so. In fact, one of the characters of the superfamily Gasterosteoidea would appear to be the nearly or quite complete exclusion of rays from the fourth actinost.

Such a condition, too, is realized or approximated among Malacopterygians (*e. g.*, Salmonids and Esocids or Luciids). It is possible that in the excessively modified Opah, deviation from the ordinary type is manifested in such exclusion as well as in other characters and may be the result of mechanical adaptation to the special conditions of position and other modification of the pectoral fin and supporting bones.

IV.

If the views as to the homologies of the bones in question are correct, the approximation of *Lampris* to the neighborhood of the Hemibranchs can not be sustained, as the only ground for it was the supposed homology of the hypocoracoid of the present article with an assumed infraclavicle. The supposititious infraclavicle (or interclavicle) of the Hemibranchs has been recently shown, in an excellent paper by Mr. E. C. Starks, to have no independent existence (a conclusion I was forced to come to on scanty material many years ago). The so-called infraclavicle of *Lampris*, then, has no counterpart among the Hemibranchs. As the supposed agreement of *Lampris* with the Hemibranchs was based mainly on the assumed possession of the same peculiar bone ("infraclavicle") by both types, the negation of that agreement involves the denial of the relationship.

But what is the relationship of *Lampris*? Cuvier and the elders were perhaps not far out of the way in approximating it to the great Scombroidean series with which it agrees in characteristic modifications of the vertebræ and clasping rays. So far as the scapular arch is concerned, the Caproids agree better than any other known form. Mr. Starks has recently published an article on The Relationship and Osteology of the Caproid Fishes or Antigoniidæ, and given therein

a figure as well as description of the "shoulder girdle of *Antigonia rubescens*." On the whole, there is considerable similarity between the corresponding parts of *Lampris* and *Antigonia*. The front border of the cœnosteon is decurved backward in both, and the proportions of the hypocoracoid and hypercoracoid do not differ very widely. The actinosts of *Antigonia*, however, are comparatively free and the suprascapula not forked. The pelvis is also quite different.

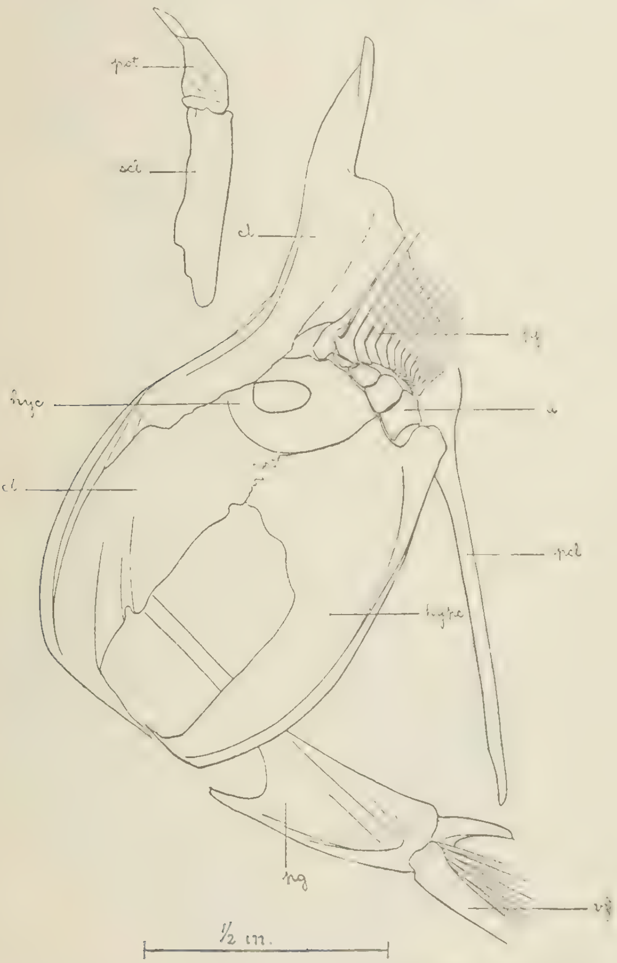

FIG. 2.—SHOULDER GIRDLE OF ANTIGONIA RUBESCENS. (FROM STARKS.)

In fine, at present apparently no better position can be found for *Lampris* than somewhere in the line of the Scombroidean superfamily. It even agrees with the Scombrids, Xiphiids, Coryphænids, Carangids and their relatives in the deep bifurcation of the roots of the caudal rays which clamp the hypural and epural bones, and provisionally at least it should be approximated to them.

Dr. Boulenger has proved, however, that the Opah is not especially related to the Scombroidea, and it is quite possible that he may be sustained in the isolation of the family Lamprididæ as representative

of a special group or suborder; at any rate, it is at least entitled to distinction as a special superfamily (LAMPRIDOIDEA). This superfamily may be briefly defined in the following terms:

V.

LAMPRIDOIDEA.

Acanthopterygian fishes with the foremost rays only spiniform, the myodome completely shut off from the cerebral chamber, ribs sessile on the centra of the vertebræ, suprascapulars connected by squamous suture and ligaments with the cranium, cœnosteons postcurved toward each other, hypocoracoids much enlarged and extended upward and backward, actinosts diverted to a nearly horizontal row, pelvic bones enlarged and connected by cartilage with the cœnosteons as well as the hypocoracoids, ventrals subabdominal and with numerous rays, and caudal rays clasping epurals and hypurals.

The family was first named in 1862, and has been adopted by the authors named in the synonymy herewith given and in a few other places. Many naturalists still prefer to leave it in the incongruous family of *Scombridæ*.

The family name was originally written *Lamprididæ*, and in this form it was adopted by Jordan and Gilbert and by others, but Jordan and Evermann have changed it to *Lampridæ*. The reason for the change is not evident and has not been given. It is possible that it may have been from confusion with λαμπρός (radiant), but the generic name is not derived directly from the Greek but modified from it, and agrees with such well-known fish names as *Chalcis*, *Etelis*, *Julis*, *Pelamis*, *Phycis*, *Smaris*, *Synagris*, and *Teuthis*, which have -id in the oblique cases (*e. g.*, -idos in the genetive, etc.). The original form of the name is consequently justified by analogy and should be retained.

The history of the nomenclature may be gleaned from the following partial synonymy:

LAMPRIDIDÆ.

FAMILY NAMES.

Lampridoidæ GILL, Proc. Acad. Nat. Sci. Phil., 1862, p. [127,] 241. (Named only.)
Lamprididæ GILL, Arr. Fam. Fishes, 1872, p. 7. (Name only.)
Lampridini POEY, Enum. Pisc. Cub., p. 93, 1876.
Lamprididæ JORDAN and GILBERT, Syn. Fishes N. Am., 1882, p. 453.
Lamprididæ GILL, Johnson's Univ. Dict., II, 1885, p. 1621 (defined).
Lamprididæ SMITT, Hist. Scand. Fishes, I, 1892, p. 121.
Lamprididæ GOODE and BEAN, Oceanic Ich., 1895, p. 222.
Lampridæ JORDAN and EVERMANN, Syn. Fishes N. M. Am., I, 1896, p. 953.
Lamprididæ BOULENGER, An. Mag. Nat. Hist. (7), 1902, p. 151.

SUBFAMILY NAME.

Lamprini MOREAU, H. N. Poiss., France, II, p. 483.

VI.

The skeleton in the United States National Museum, so far as the scapular arch is concerned, naturally manifests essential similarity with the one figured by Dr. Boulenger. There are certain differences, however, which are noteworthy. The cœnosteon[a] and hypocoracoid terminate in and are united by cartilage which also extends backward and under the hypocoracoid to connect with the infero-anterior angle

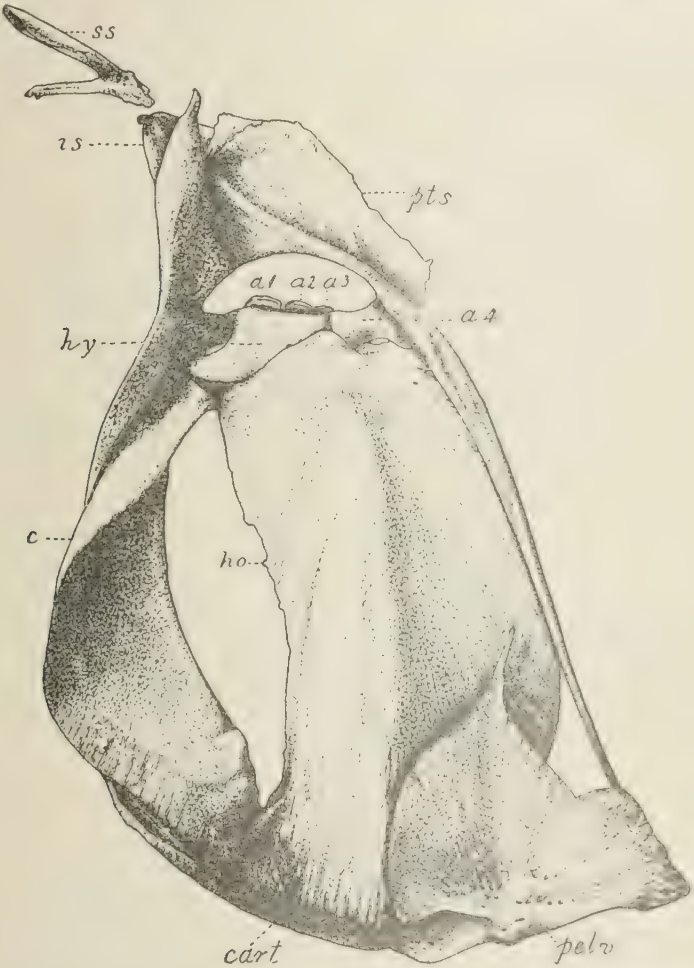

FIG. 3.—SHOULDER GIRDLE OF LAMPRIS GUTTATA, INNER VIEW. (FOR LETTERING SEE P. 916.)

of the pelvic bone. The upper half of the anterior border and most of the posterior border approximate more toward a straight oblique line than the corresponding margins of Boulenger's specimen. The

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[a] Several names I have previously used have been abandoned in this communication, post-temporal giving place to the previously named *Suprascapula*, posterotemporal to *Interscapula*, and proscapula to *Cœnosteon*.

Cœnosteon is named in the Synonymy of the Fish Skeleton, by Mr. Edwin Chapin Starks, but without any data. In the Proceedings, Washington Academy Sciences

interscapula has a convex inferior margin and reminds one of the lower mandible of some cuttlefishes. The postscapula is more decurved. The cœnosteon and hypercoracoid are connected toward the front at the symphysis by the intervention of cartilage.

The hypercoracoid has a foramen which appears as a notch from the outer side as the result of the overlapping of the cœnosteon by squamous suture, but internally the bone extends forward and is separated from the cœnosteon by a long unguiform gap and intervening cartilage or membrane.

The fourth actinost is much broader in front than in the British Museum skeleton and its posterior portion much more deflected and wedged in between the hypocoracoid and styliform extension of the postscapula, which is suturally connected with it as well as with the hypocoracoid; there is little cartilage between its anterior portion and the hypocoracoid as well as third actinost. The third actinost intervenes between the hypercoracoid and fourth actinost, quite widely separating them, and has the same kind of union with the fourth as with the third; the second is longer, and has an oblong convex articular surface; its sutures, though close, are well defined; the first actinost has a still larger, more oblong, and more convex articular surface, and is so intimately connected with the hypercoracoid that the sutures are obliterated; it is, in fact, completely "fused with" the hypercoracoid.

The pelvic bones are connected with the postflected lowermost or symphysial angles of the cœnosteons through the intervention of cartilage and have lamellar extensions, separated by fissures from the body of the bone, which are connected by cartilage with a slightly defined ridge of the hypocoracoid parallel with its anterior margin. The ventrals are subabdominal and inserted in the pelvic bones some distance in advance of the hinder ends of those bones.

VII.

The pectoral fins of the Opah are represented inclined downward in Smitt's Scandinavian Fishes (I, p. 123, 1892), as they are in the old article by Günner. Boulenger remarks, "On examining the shoulder bones on a skeleton of *Lampris luna*, I was struck by two things—first,

(III, p. 521, 1901) the word is quoted under "55, Clavicle, Parker," and in a footnote the following remark is made: "I get this reference from Owen's Comp. Anat. Lectures (Vertebrates), p. 118. By some ichthyotomists the bone in question has received the special name of Cœnosteon." The name was given by Bakker in his "Osteographia Piscium" (1822). Bakker thought that the so-called clavicle of fishes was more than the clavicle of other vertebrates, corresponding to the clavicle and humerus together (Nec tamen claviculam solam facere, sed e clavicula et osse humeri componi mihi visum est, p. 111), and consequently gave the name cœnosteon (evidently from κοινός, common or shared in common, and ὀστέον, bone). The implication is certainly false, but the name itself may be retained.

that the disposition of the articulating facets of the pterygials allows of a much greater downward than upward movement of the rays of the pectoral, by which the fin can be pressed down close against the sides of the body, and precludes the opposite vertical position—a fact which I have been able to verify on a specimen in the flesh. This mode of articulation seems so contrary to our ideas that most figures and stuffed specimens represent the pectoral fin directed upward, as in *Brama*, to which the Opah was believed to be related."

It is noteworthy that representatives of the genus *Pempheris* are also able to deflect their pectorals against the sides of the body, but they are not limited to that movement and can fold the fins backward.

VIII.

The Opah appears to be not rare in certain regions, and the paucity in collections is probably due to the want of sufficient motive to hunt for them rather than absolute rarity or difficulty in obtaining them. In the Twentieth Annual Report of the Fishery Board of Scotland (1902), kindly sent to me recently, there is an interesting record (p. 541) of individuals "landed at Aberdeen market during 1891," with a "note of the place where they were stated to have been caught." In June, "three specimens;" in July, ten; in August, one, and in September two were received. All "were taken by line" and the one was caught at a depth of 125 fathoms.

The only previous notice of the capture of the Opah off the coast of Aberdeenshire I am acquainted with is one published in the Zoologist for 1896. It appears from an anonymous note in that magazine for August[a] on The Opah or Kingfish off Aberdeen that "there was lately on view at Messrs. J. and T. Sawers's fish market, Belfast, a fine specimen of the Opah or Kingfish caught off the coast of Aberdeenshire. It weighed 70 pounds, was about 4 feet long, and measured 2½ feet at the broadest part."

IX.

The etymology of the curious name Opah is stated to be unknown by the various English dictionaries, as the Century Dictionary ("Opah (ō′pä) *n.* [Origin unknown]").

Further research would have revealed it. The first appearance of the name with explanation is in 1750, in the Philosophical Transactions (vol. 46). Therein is published "The Defcription of a Fifh fhewed to the Royal Society by Mr. Ralph Bigland, on March 22, 1749-50: Drawn up by C. Mortimer, M. D., Secret. R. S." (pp. 518-520.) This seemed to the author "to be a new Species of Fifh not yet defcribed by any author." It was a *Lampris*, and immediately after the dec-

[a] 3. S., XX, p. 306.

laration just quoted the author appended the following two paragraphs. The italics, capitals, antique s(ſ), orthography, and brackets are reproduced from the original:

"The black Prince, and his Couſin, from *Anamaboe* on the Coaſt of *Guinea*, and Mr. *Creighton*, formerly Governor of *Capo Corſo Caſtle*, upon ſeeing this Fiſh immediately knew it, and ſaid it was common on that Coast, and is very good to eat. The Natives call it *Opah*, and the Engliſh there call it the *King fiſh*. I ſhall therefore retain the *Guinea* Name, with theſe Characteriſtics; OPAH *Guinienſium eſt piſcis oſſeus, non ſquammoſus, edentulus; habens unicam in dorſo pinnam anteriùs aculeatam, pone branchias par pinnarum, in medio ventre par pinnarum, ad poſticam ventris partem unicam pinnam, caudam forcipatam.*

"Mr. *Bigland* ſays, that, upon opening of it, all its Bowels would have gone into a Quart-Mug: that the Fleſh of the fore Part was firm, and look'd like Beef, and the hinder Part like fine Veal; that the Bones were like thoſe of Quadrupeds: particulary the Shoulder-blades, which reſembled thoſe of Sheep. [See an Article in the *Scots Magazine* for *October* 1748, printed at *Edinburgh* in 8*vo*.] In a Letter to me, he adds, that probably this was a [Pelagian or] Ocean Fish, wandring by chance into the Frith of *Forth*; and, by the Tide ebbing, being left upon a conſiderable Shoal, or flat Sand, near *Leith*, was diſcover'd from Land in a State of Distreſs; whereupon ſome Fiſhermen plunged into the Sea, and with a Net ſurrounded it, and brought it to Shore."

It is not at all probable that "the black prince" or the "former governor of Capo Corso" ever saw a specimen of *Lampris*. The fish has never been recorded from the western coast of tropical Africa, and it certainly is not and never "was common on that coast." Inasmuch, however, as it is a wide-ranging pelagic form, it is no more impossible that an individual may have been caught near the coast of Africa than that one was actually caught near Cuba. Probably, however, the origin of the name is due either to the fancy of a negro chieftain and the subserviency of a white man, or to a misunderstanding or misrepresentation of what was said. It was a "ghost-word," at least so far as the *Lampris* is involved.

AMPHIPODA FROM COSTA RICA.

By Rev. Thomas R. R. Stebbing.
Fellow of the Royal Society.

The specimens here described were sent to me for determination by the United States National Museum, and represent two new species. They were collected by Prof. P. Biolley, of the National Museum of Costa Rica.

Family TALITRIDÆ.

1900. *Talitridæ* Stebbing, Fauna hawaiiensis, II, p. 527.

TALORCHESTIA FRITZI, new species.

Plate LX.

The largest of the male specimens have the peræon transversely corrugated, each of the segments showing two folds, except the first segment, which has a single fold. All the specimens, however, 15 in number, have the integument brittle and most of the muscular parts shrunken. The exceptional corrugation, therefore, in the large male examples may not be a natural feature, but merely due to conditions experienced since their capture. In the synoptic table published four years ago[a] for discriminating the genera of the Talitridæ, at that time called Orchestiidæ, the leading distinction between *Orchestia* and *Talorchestia* rests on the fact that in the former the first gnathopods of the female are subchelate, whereas in the latter they are simple. So far as this distinction is concerned, the present species clearly belongs to *Talorchestia*. The sixth joint of the limb in question has no distal widening to furnish a "palm" upon which the finger can close. In *Orchestia* the widening is seldom or never very great, but how far it may be reduced without effecting generic change has not yet been determined.

The eyes may be described as rotundo-quadrate, with a diameter much larger than the interval between them.

First antennæ of male have the middle joint of the peduncle slightly the longest, the five-jointed flagellum about half as long as the peduncle, the whole appendage being subequal in length to the last joint in the peduncle of the second pair. In the female the flagellum has three

[a]Trans. Linn. Soc. London, Zool., 2d ser., VII, Pt. 3, 1899, p. 397.

joints, and the whole appendage is nearly as long as the last two joints of the peduncle in the following pair.

In the adult male the second antennæ have the peduncle massive, its last joint a little longer than the penultimate, the flagellum consisting of 14–17 joints, many of which widen distally, with minute spines thrust into prominence. In the female, already carrying marsupial plates, the antennæ, as shown in the figure, are of insignificant size compared with those of the male. The ten-jointed flagellum equals in length the last two joints of the peduncle.

The mouth organs exhibit no distinctive peculiarity. The palp of the first maxillæ is minute. No trace of a fourth joint could be perceived on the palp of the maxillipeds.

The first gnathopods of the male have the long wrist or fifth joint distally widened, and on the inner side of the spinulose prominence is a pellucid bubble-like tubercle. The sixth joint is shorter, but similarly widened, its prominence beset with spinules and capped with a pellucid portion like the bubble on the preceding joint. The small, conical finger closes over a shallowly excavate palm, its point reaching but by no means overlapping the clear prominence. In the female the wrist is distally widened, but without special prominence or tubercle, while the sixth joint is for some distance parallel-sided, and then, instead of widening, tapers slightly to the insertion of the finger. Like the preceding joint, it has spines on both margins, those on the hinder or inner margin being the more important.

The second gnathopods of the full-grown male have large oval hands, with the palm very oblique, beset on both sides with spines, and in the middle slightly flattened, so as to leave a shallow interval when the massive, strongly curved finger closes, bringing its apex into the pocket at the end of the palm. Near the hinge of hand and finger the palm has a short but rather deep excavation, into which a corresponding prominence of the finger's inner margin neatly fits. This notable feature occurs elsewhere in the Talitridæ, as in *Orchestoidea tuberculata* Nicolet, *Orchestia tucurauna* Fritz Müller, and *Orchestia sulensoni* Stebbing. These stand, it is true, in different genera, but the generic position of the third is obscure, because the female is not yet known. It is, however, clearly distinguished from the species now under discussion by the different character of its first gnathopods. With Fritz Müller's species there are other difficulties, as will appear by the following quotation from his celebrated treatise.[a] Müller is calling attention to the fact that the development of the sexual peculiarities does not stand still on the attainment of sexual maturity, and proceeds to give instances:

For example, the younger sexually mature males of *Orchestia Tucurauna*, n. sp., have slender inferior antennæ, with the joints of the flagellum not fused together,

[a] Fur Darwin, 1864, p. 54; Accurately translated by Dallas under the title, Facts and arguments for Darwin, 1869, pp. 79, 80.

the clasping margin ("palm," Sp. Bate) of the hand in the second pair of feet is uniformly convex, the last pair of feet is slender and similar to the preceding. Subsequently the antennæ become thickened, two, three, or four of the first joints of the flagellum are fused together, the palm of the hand acquires a deep emargination near its inferior angle, and the intermediate joints of the last pair of feet become swelled into a considerable incrassation. No museum-zoologist would hesitate about fabricating two distinct species, if the oldest and youngest sexually mature males were sent to him without the existing intermediate forms. In the younger males of *Orchestia Tucuratinga*, although the microscopic examination of their testes showed that they were already sexually mature, the emargination of the clasping margin of the hand (represented in fig. 50) and the corresponding process of the finger, are still entirely wanting. The same may be observed in *Cerapus* and *Caprella*, and probably in all cases where hereditary sexual differences occur.

A footnote says that fig. 50 represents the second gnathopod of the male, and fig. 51 that of the female, of *Orchestia tucuratinga*.

The original German edition adds the letters "n. sp." after the mention of *O. tucuratinga*. For the translation Müller himself supplied corrections of printer's errors in the original. Yet we find *O. tucurauna* and *O. tucuratinga* left side by side both in the text and index of the English edition. If they are one and the same species, the remarks on the differences between the young and old males are needlessly repeated. If they are distinct species, not the smallest character is assigned by which they can be distinguished. No museum zoologist could have made a worse muddle. Nothing is said about the first gnathopods of either sex. If these were left unexamined, the species might belong to *Orchestoidea* or *Talorchestia* just as well as to *Orchestia*.

A general resemblance in the second gnathopods of the Costa Rican species to those figured by Fritz Müller excited a hope that his description might be supplemented from the specimens now in hand. The hope was dissipated by more exact comparison. Though the young males showed the uniformly convex palm and smoothly concave finger-margin of the second gnathopods, combining with these the common youthful characters of slender second antennæ and slender hind peraeopods, the older males and the females did not fall into line with the species represented by Müller. The length, compared with the breadth of the large hands, is much greater in the present species than in his, and the palm is less convex. Also in the delicate second gnathopod of the female there are several differences, most easily seen by a comparison of the figures. In the species here described the second joint, instead of being oval, has a straight hind margin and sinuous front one, the fifth and sixth joints are narrower than in Müller's species, and the rounded apex of the sixth is much more produced beyond the minute chela-forming finger. It may be added that, though the peduncles of the second antennæ are greatly thickened in the large males, the initial joints of the flagella show no additional fusion, nor is the thickening of the middle joints in the hind peraeopods especially conspicuous.

The first peræopods are rather longer than the second. The latter have, as usual, the small finger notched on the inner margin near the apex. The fourth and fifth peræopods are much longer than the third. The second joint in the fifth pair is much broader than that in the fourth, being about as broad as it is long.

The hind corners of the second and third pleon segments are quadrate. The first uropods have equal rami, nearly as long as the peduncle. The second pair are shorter, with the rami equal and as long as the peduncle, the inner ramus so placed as not to reach quite so far back as the outer. The slender ramus of the third pair carries a row of four little spines. It is shorter than the stout peduncle. The sixth pleon segment is dorsally incomplete, having the gap in its armour cloaked by the telson. The telson has a dividing line down the center, the apex being bilobed, carrying two or three spinules on each lobe, and a pair of sublateral spines is placed higher up.

The male specimen, of which the parts are figured in the accompanying plate, measured from front of head to end of uropods seven-twentieths of an inch, while a male with notch in palm of second gnathopods still undeveloped was only four-twentieths of an inch long, or 5 mm. as contrasted with about 9 mm. in the larger example.

The specimens were forwarded to me as having been taken in January, 1902, by Mr. P. Biolley, at Isla del Coco, off Costa Rica.

The specific name is chosen to direct attention to the points of comparison between this form and that which for the present should be known as *Orchestia tucurauna* Fritz Müller.

HYALELLA FAXONI, new species.

Plate LXI.

The back is well rounded, devoid of teeth. The first three segments of the pleon have the postero-lateral angles acute, those of the first pair being scarcely, but those of the third conspicuously, produced.

The eyes are round, very small, and wide apart.

The first antennæ have the peduncle well developed, but with the third joint a little shorter than the second, and the second than the first. The flagellum is elongate, its joints attaining to fourteen in number in the male. A specimen in which the flagellum was eleven-jointed had the eleventh joint about level with the eighth joint of the flagellum of the lower antennæ.

The second antennæ have both peduncle and flagellum longer than those of the preceding pair, the terminal joint of the peduncle considerably longer than the penultimate in the male, but very little longer in the female, an unbroken flagellum in the male having as many as seventeen joints. In a female specimen a flagellum of thirteen joints answers to one of ten in the first pair.

The first maxillæ have three setæ on the apex of the inner plate, instead of the two which appear to be the usual number in this genus.

The first gnathopods have a spiniferous boss, more developed in the male than in the female, on the hind margin of the fourth and fifth joints, and the palm of the subparallel-sided hand nearly transverse, not overlapped by the small finger.

In the male the large second gnathopods are very similar to those of *Hyalella dentata* Smith, and *Hyalella longistila* (Faxon), but the hand is rather longer in proportion to the breadth. The palm ends in a slight bulging beyond the pocket into which the apex of the strongly curved finger closes. Near the hinge of hand and finger the palm has a somewhat tooth-like indent, just like the "notch" of *H. dentata* as figured and described by Prof. S. I. Smith, the slope of the palm being nearly straight and beset on each side with spines. In the female the hand is as long as the wrist, considerably wider distally than in the proximal half, the small, closely shutting finger not reaching the end of the palm. So far as can be judged from Professor Smith's complete lateral view of the female of his *H. inermis*, both gnathopods in the female of that species are in close agreement with those of the present species.

The third peræopods are much shorter than the fourth or fifth pairs. In all three the second joint may be described as large and broadly oval, but in the fifth pair it is considerably broader and more rounded than in the other two pairs, with a length not much greater than the breadth. No "accessory branchiæ" were observed in connection with any of the limbs.

The third uropods are quite small, with the ramus tapering, nearly as long as the peduncle, but much narrower.

The telson is almost square, the distal margin carrying a pair of setules, its corners rounded.

A male specimen measured from front of head to the extremity of the slightly bent pleon three-tenths of an inch (7.5 mm.).

The specimens, 20 in number, were labeled as coming from a height of 2,400 meters, or 8,000 feet, on Volcan Reventado, and collected by Mr. P. Biolley.

The specific name is given in compliment to Dr. Walter Faxon, who in 1876 described several species of this genus and directed attention to some of the difficulties attending the delimitation of species within it. Dr. Faxon at that date[a] writes: "After an examination of a large number of *Hyalella dentata* and *H. inermis* from Utah, I am satisfied that they are but varieties of one species. The form with dorsal teeth on the first and second abdominal segments is very probably synonymous with *Amphitoe aztecus* Saussure[b] and

[a] Bull. Mus. Harvard, III, p. 374.

[b] Mémoire sur divers Crustacés nouveaux du Mexique et des Antilles, 1858, p. 58, pl. v, fig. 33.

Allorchestes knickerbockeri Bate,[a] as pointed out by Professor Smith himself." It may be convenient to accept Saussure's name for the dentate form, although his description is vague and his figures rough. In the large second gnathopod, of which he gives a detailed figure, the wrist or fifth joint is entirely devoid of the characteristic projecting process. In my opinion the same motive of convenience is sufficiently strong to justify the retention of the specific name *inermis* for the form that is not dentate. This I have applied to specimens obtained by Mr. Edward Whymper at great heights in Ecuador.[b] None of these had dentate body segments. On first examining the specimens from Costa Rica, I was disposed to identify them with the species submitted to me by Mr. Whymper. About the close general resemblance there can be no question, but in detail I find the following differences: The new species here described has the antennæ of both pairs more elongate, the first joint in the third, fourth, and fifth peræopods larger and more broadly oval, and the postero-lateral angles of the third pleon segment much more decidedly produced. None of these characters, it must be confessed, are easy to appreciate except by comparison of actual specimens or of accurate figures drawn to the same scale. But the mouth organs show a curious feature, in that the first maxillæ, as above stated, have three setæ on the apex of the inner plate, alike in male and female, while *H. inermis* has only two. In the male of *H. faxoni* the first gnathopods have the hand not, or very little, broader at the palm than in the middle, whereas the *H. inermis* from Ecuador has a strong bulging of the palm beyond the point which the finger reaches, making the hand as broad as it is long. Also in the large second gnathopods there is a stronger bulge at the corresponding point, making the breadth of the hand in the Ecuador species greater in proportion to its length, and the "notch" at the other end of the palm is rounded off.

EXPLANATION OF PLATES.

Plate LX.

Talorchestia fritzi, new species.

n. s. Length of male specimen examined, not including the antennæ.
a. s., *a. i.* The upper and lower antennæ, respectively, of the two sexes, with further enlargement of two joints of the flagellum in lower antennæ of male.
gn. 1, *gn.* 2. First and second gnathopods, respectively, of the two sexes, with further enlargement of some of the distal joints.
prp. 2. ♀. Second peræopod of the female, with enlargement of finger.
prp. 5. Fifth peræopod of the male.

[a] Catalogue of the specimens of Amphipodous Crustacea in the Collection of the British Museum, 1862, p. 36, pl. VI, fig. 1.

[b] Travels among the Great Andes of the Equator, Appendix, 1891, p. 125.

ur. 1. Lateral view of first uropods of male, together with the second and third uropods and telson, in attachment to the fourth, fifth, and sixth segments of the pleon.

ur. 3. ♀. Third uropod of female.

T. Telson of female.

PLATE LXI.

Hyalella faxoni, new species.

n. s. Length of male specimen examined, not including the antennæ.

a. s., *a. i.* Upper and lower antennæ of the two sexes.

mx. 1. First maxilla (from a separate specimen).

gn. 1, *gn.* 2. First and second gnathopods of both sexes, with further enlargement of distal portion.

prp. 5. Fifth peræopod of male.

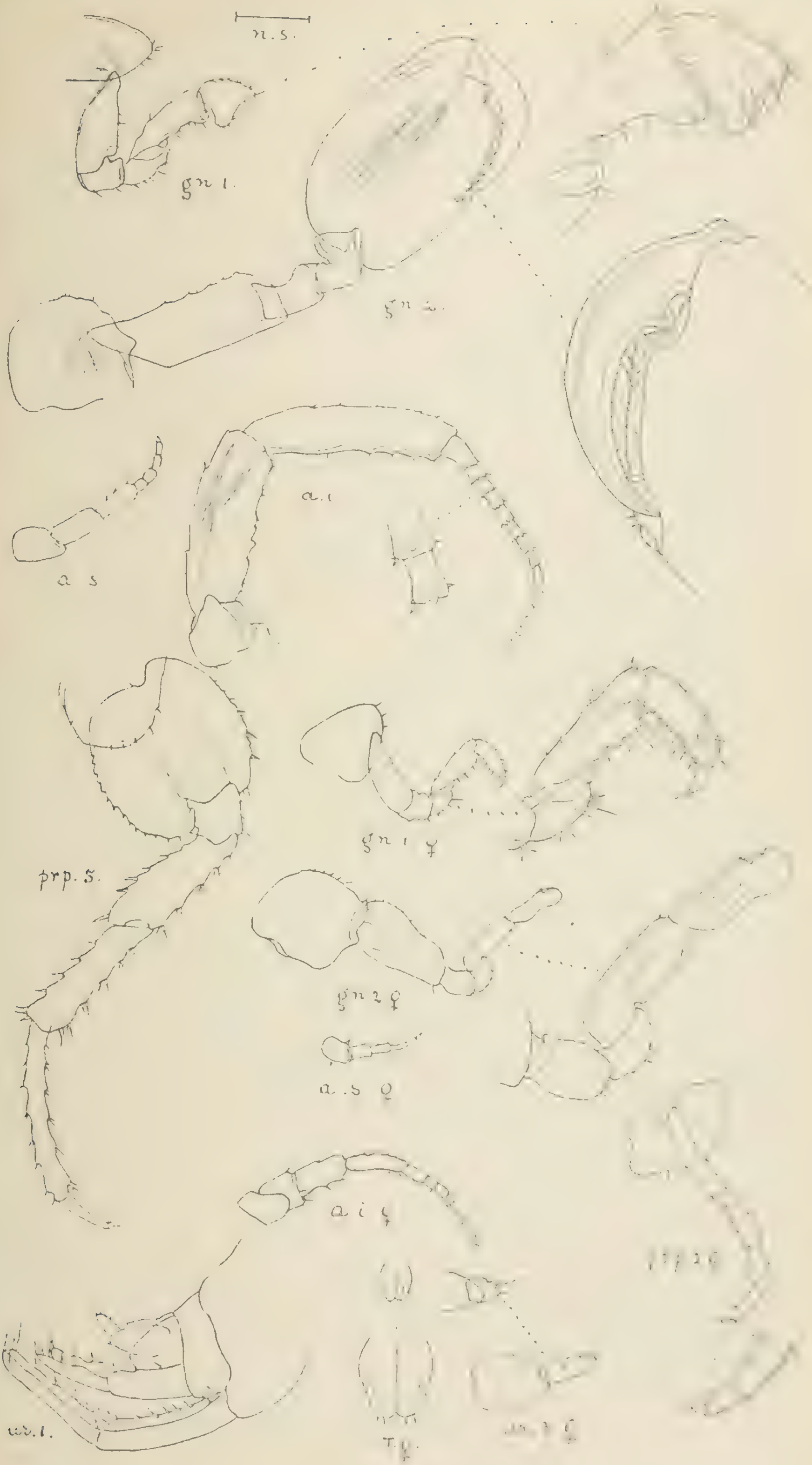
Pl. s. 3. ♀. Third pleon segment of female.

ur. 3. Third uropod, respectively, of male and female.

T. Telson of each sex, that of the male from the specimen of which the first maxilla is figured.

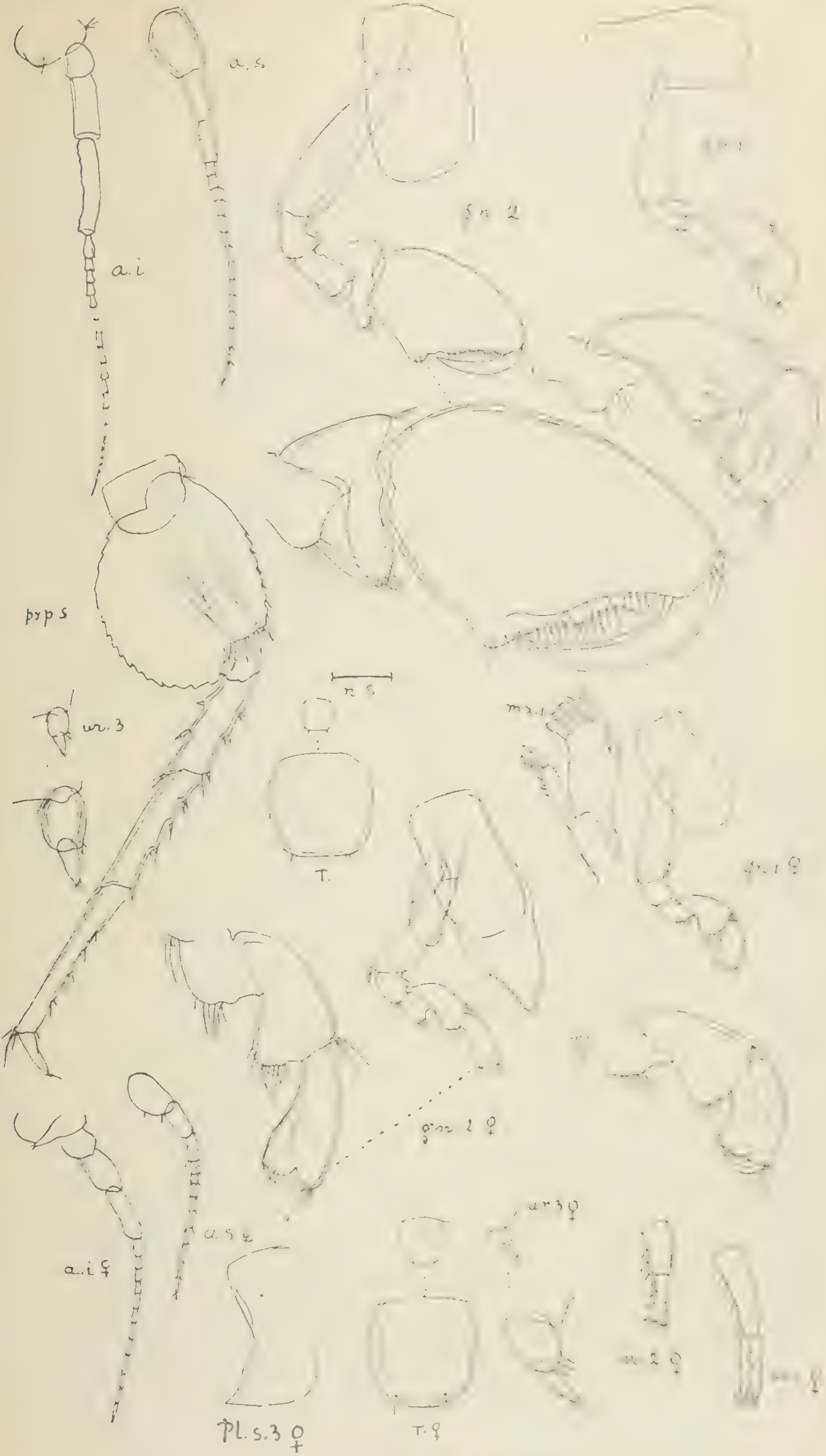
The figures are from male specimens, unless accompanied by the symbol of the female (♀).

Only two scales of magnification are employed, all the figures except one being drawn to the lower scale, while some are wholly or partially duplicated on the higher scale. The first maxilla of *Hyalella faxoni* is represented only on the higher magnification.



TALORCHESTIA FRITZI, NEW SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 930.



HYALELLA FAXONI, NEW SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 931.

SYNOPSIS OF THE FAMILY ASTARTIDÆ, WITH A REVIEW OF THE AMERICAN SPECIES.

By William Healey Dall,

Honorary Curator, Division of Mollusks.

The group of bivalve shells which composes this family is of ancient origin, the *Crassatellitidæ* having diverged from it in the later Mesozoic and taken definite form in the Eocene. The chief characteristic by which the two families are discriminated is found in the ligament, which in *Astartidæ* is external as well as the resilium, while in the *Crassatellitidæ* this organ is separated from the resilium, the latter, except in *Eriphyla*, being deeply immersed. In *Eriphyla* the process has only begun, but the other characteristics of the shell are so close to *Crassinella* that the two must obviously be associated in the same family. In *Lirodiscus* of the *Astartidæ* the resilium is separated from the ligament, but still remains external, while the other characters link it to *Astarte* in a way analogous to those which bind *Eriphyla* to the Crassinellas; so each family has an exceptional and peripheral group.

Concentric sculpture, dense periostracum, absence of bright color pattern, and a hinge formula of, in its fullest development, the following elements $\left(\begin{matrix}\mathrm{L}0.101010.1\\ \mathrm{R}1.010101.0\end{matrix}\right)$ are characteristic of this family, as is its preference for cold waters, the tropical species keeping chiefly in the cold abysses or being dwarfed in size. The *Crassatellitidæ*, on the other hand, are prevalent in the Tropics and unknown in the cold seas.

I have not found more than three cardinals in either valve, and there are usually several nearly obsolete. The laterals are formed by an extension of the valve margin, which fits into a groove or socket in the opposite valve. These are usually alternated, one lateral and one socket to each valve. The middle cardinals are usually well developed and sometimes bifid, the anterior right and posterior left cardinals always (and the posterior right cardinal often) more or less obsolete. The sides of the cardinal teeth are frequently vertically striated, as in *Crassatellites*, especially in the fossil species.

No *Astarte* has radial ribbing, but many develop in the adult state crenulations on the inner margin of the valves. Some species are crenulate only when fully adult, others develop crenation at resting stages, others are always without them. The teeth of the hinge are frequently reversed as regards the valves. The laterals vary extremely in the fullness of their development, and the outline of the valves is also often very variable, most of the trigonal species having also elongated or oblique varieties. The conditions in the boreal seas, where these animals chiefly abound, seem to make for profusion in individuals and paucity of species, a state of things obviously favorable to individual variation.

The dullness of color characterizing the shells of this group is to some extent made up for by the bright colors of the soft parts which are usually yellow, orange, or vermilion. The anal siphon is short, complete, plain-edged and valvular. The branchial siphon is formed by apposition of the ciliate border of the free mantle edges. The foot is subquadrate, the gills small, reticulate, and free. The eggs are ripe in April in the latitude of Long Island Sound, and are discharged into the water for fertilization. The animals live partly immersed in mud or sand and form a large part of the food supply of the walrus and many fishes. The variability previously alluded to has made the identification of species difficult and their synonymy almost hopeless.

Dr. Jeffreys, who published much about the northern fauna, unfortunately was disposed to lump together rather than discriminate, not having the large series necessary for elucidating our American species. Sowerby's monographs of this group are very unsatisfactory and imperfect, covering less than half the known forms. The most successful attempt at a review of the species is that of Mr. Edgar A. Smith, of the British Museum, in 1881, in the Journal of Conchology.

I have found in reviewing our American species that a more narrow specific limitation removes some of the difficulties surrounding the subject. While assenting to many of the views heretofore expressed by naturalists, and disavowing any claim of finality for the decisions arrived at, I have endeavored to discriminate the recognizable American forms whether these be regarded as species or not. By adopting names for them we at least have the satisfaction of knowing what we mean when we employ a name, which is impossible under the system, or want of system, of Dr. Jeffreys. For the same reason I have been unable to avail myself of much work, systematic and distributional, which is in print, since it is impossible to know which of several forms is intended in a given case where a name covering a number of types has been used. The distribution mentioned in my list herewith is taken from actual specimens and only exceptionally from the literature. The collection of Astartes from the boreal regions of the New

World in the National Museum is exceptionally large, a fact upon which the possibility of a review of the species is dependent. In a general way the species common to both hemispheres belong to the circumpolar fauna; extremely few if any of the more southern species are common to Europe and America. In a general way each fauna has a set of species in which a given type is represented, but the representatives of the type when compared are found to be similar rather than specifically identical. Thus, the European *A. sulcata*, *compressa*, and *incrassata* do not in my opinion occur at all in America, though the Atlantic and Pacific faunas have analogues which are probably due to filling a particular similar niche in the environment rather than to any close connection with the types of Europe referred to.

The distinctions upon which the subordinate groups of *Astartidæ* are founded are chiefly the greater or less development of the hinge teeth and modifications of external sculpture. As the type of the hinge formula does not change but merely submits to certain deductions from its possible total, it will be inferred that the subgenera or sections are not very widely separated.

The genus *Goodalliopsis* Munier-Chalmas and De Raincourt, 1863, is a synonym of *Kellia*. *Plesiastarte* Fischer, 1887, which has also been referred to this family, may perhaps be more suitably placed in the *Cyrenidæ*, if not a nepionic shell. *Praeconia* Stoliezka, 1871, and *Pachytypus* Munier-Chalmas, 1887, I have not been able to examine; both are fossils. *Parisiella* Cossmann, 1887, from the figures, may be a member of this family and related to *Microstagon*. It is from the French Eocene. Paleozoic forms referred to *Astarte* are dubiously pertinent.

SUBDIVISIONS OF THE FAMILY.

Genus LIRODISCUS Conrad, 1869.

Shell solid, inequilateral, equivalve, the nepionic valves flat, usually concentrically ridged, the later portion of the disk more convex; ligament normal, external; residium separate, situated between the beaks, external, but with its base encroaching on the umbonal ends of the cardinals; dental formula $\frac{\text{L01.1010.01}}{\text{R10.0101.10}}$, the left anterior lateral often indistinct; inner margins crenate; adductor scars rounded with elevated margins.

Type *Astarte tellinoides* Conrad, Claibornian Eocene. This genus appears in the lowest Eocene and continues to be represented until the Jacksonian.

Genus ASTARTE Sowerby, 1816.

Synonyms: *Tridonta* Schumacher, 1817; *Crassina* Lamarck, 1818; *Triodonta* Agassiz, 1847; *Nicania* Leach, 1819; *Gonilia* Stoliczka, 1871; *Crassinella* Bayle, 1879, not Guppy, 1874; *Neocrassina* Fischer,

1887; *Grotriania* Speyer, 1860; *Digitaria* S. V. Wood, 1853; *Woodia* Deshayes, 1860; *Rictocyma* Dall, 1872; *Rhectocyma* Von Martens, 1874; *Goodallia* Turton, 1822; *Mactrina* Brown, 1827; *Microstagon* Cossmann, 1896; *Crenimargo* Crossmann, 1903.

Ligament enfolding the resilium, both external, on narrow nymphs.

Section *Astarte* s. s. Dental formula $\frac{\text{L0.101010.1}}{\text{R1.010101.0}}$, the middle right and two left anterior cardinals strong, the others obsolete; valves with convex umbones, subequilateral, the inner margins crenate when fully developed. Type, *Astarte sulcata* (Da Costa).

Section *Tridonta* Schumacher. Like *Astarte*, but the inner margins always smooth. Type, *T. borealis* Schumacher, 1817.

? Section *Neocrassina* Fischer. Like *Astarte*, but the umbones nearly terminal in front. Type, *A. obliqua* Deshayes. Bajocien Oolite.

Section *Rictocyma* Dall. Small, like *Astarte*, but the valves with irregular bifid or broken sculpture; inner margins not crenate. Type, *A. esquimalti* (Baird).

Section *Ashtarotha* Dall, 1903. Umbones concentrically sculptured and conspicuously flattened; disk smoother outside of the flattened area; otherwise like *Astarte*. Type, *Astarte undulata* Say, Miocene. *A. bipartita* Sowerby, 1829, appears to belong here.

Section *Gonilia* Stoliczka. Small, lentiform, hinge as in *Astarte*; disk with divaricate ribbing centrally. Type, *Lucina bipartita* Philippi, 1839 (= *Astarte bipartita* Stoliczka, 1871, not of Sowerby; = *Astarte calliglypta* Dall, 1903).

Section *Digitaria* S. V. Wood. Valves rotund, shell small, lentiform, hinge as in *Gonilia*, having the larger cardinals bifid; surface obliquely, arcuately sulcate, the sulci grooving more or less the inner margin tangentially; *Woodia* Deshayes is synonymous. Type, *Tellina digitaria* Linnæus.

Section *Crenimargo* Cossmann. Shell like *Digitaria*, but the surface smooth; the tangential sulcations of the inner margin are, however, retained as in *Transennella;* hinge as in *Digitaria*. Type, *C. inæquicrenata* Cossman, Parisian Eocene.

Subgenus **Goodallia** Turton. Shell small, smooth, the hinge teeth reduced by the absence of the anterior or posterior right cardinal or both of them; inner margins crenate at resting stages only; dental formula $\frac{\text{L0.101.1}}{\text{R1.010.0}}$. Type, *Mactra triangularis* Montagu. *Mactrina* Brown is synonymous.

Section *Microstagon* Cossmann. Like *Goodallia*, but the hinge usually with one or both laterals obsolete and a small (usually anterior) right cardinal present, which is not found in *Goodallia* proper.

Formula $\frac{L.1010.}{R.0101.}$ (*herouvalensis*) or $\frac{L.1010.1}{R.0101.0}$ (*pernitidum*). Type. *Goodallia herouvalensis* Deshayes. Eocene of Paris.

In considering the distribution of the species the following table may aid in grasping its chief features. The East American fauna here is that south of Greenland, the West American that south of Bering Strait. The Arctic fauna includes those north of those limits, an asterisk denoting that the species is confined to the limits of its fauna as above defined.

ARCTIC AMERICAN FAUNA.

A. undata.	*T. vernicosa.*
A. subæquilatera.	*T. elliptica.*
A. crenata.	*T. acuticostata.**
A. polaris.	*T. globosa.**
T. arctica.	*T. pulchella.**
T. borealis.	*T. banksii.**
T. fabula.	*T. striata.*
T. bennettii.	*T. soror.*

WEST AMERICAN.	EAST AMERICAN.
A. polaris.†	*A. subæquilatera.*†
*T. rollandi.**	*A. castanea.**
T. arctica.†	*A. undata.*
T. borealis.†	*A. crenata.*†
*T. alaskensis.**	*A. smithii.**
*T. compacta.**	*A. globula.**
T. fabula.†	*A. nana.**
T. bennettii.†	*A. liogona.**
T. vernicosa.†	*T. borealis.*†
*R. esquimalti.**	*T. elliptica.*†
	*T. quadrans.**
	T. striata.†
	T. soror.†

ANTARCTIC FAUNA.

Astarte longirostra.

From this it will be observed that the typical Astartes, which are rather abundant on the shores of Europe, compared with the Tridontas, are in the majority on the Eastern coast, but in the Arctic they form a much smaller proportion, and only one reaches the West American fauna. *Rictocyma* is confined to the latter. In this hemisphere the Arctic fauna has 4 peculiar species, Eastern America 6, and Western America only 4. Only one species, *A.* (*Tridonta*) *borealis*, is common to all three of the northern faunas. If we eliminate from the east and west faunas those really arctic species which invade them from the north (and which are marked with a dagger in the table), we find only the peculiar species left, except in the case of *A.*

undata, which occurs in Greenland, but is very rare there, and really is characteristic of the fauna farther south.

The *Astarte* fauna of the American hemisphere thus consists of 27 species, 1 being Antarctic, 16 Arctic, 13 East and 10 West American. Doubtless a more thorough exploration of the arctic and abyssal seas in both oceans might add a few more species and somewhat change the above figures.

In the geographical lists which follow the names have appended to them the date of description. The more detailed references, if desired, may be had from the bibliography in the Journal of Conchology for 1881, given by Mr. Edgar A. Smith, pages 201–204.

The plates contain figures of the newly described or unfigured forms.

LIST OF THE SPECIES OF THE EASTERN COAST.

ASTARTE CASTANEA Say, 1822.

Coast of Nova Scotia and southward to the vicinity of Cape Hatteras, North Carolina, in 5 to 65 fathoms.

A variety, *picea* Gould, 1841, has blackish tarry periostracum. It has been collected at Chelsea Beach, Massachusetts, and Sandy Hook, New Jersey. The typical form is smooth, equilateral, polished, of a rich reddish chestnut brown, and with sharply crenate margins.

Totten described a variety, *procera*, from Provincetown Harbor, Massachusetts, in 1835. It is characterized by a dull yellow brown periostracum and obliquely produced high beaks. It would seem that the peculiar environment is connected with these characters, as the locality is so isolated as to be almost like an oceanic island, and on the Pacific coast on such islands exclusively a variety of *A. rollandi* is found differing from the type in the same way.

ASTARTE UNDATA Gould, 1841.

Greenland and adjacent arctic waters, and south to Massachusetts Bay, and in deep cold water to the vicinity of Chesapeake Bay. The range in depth is from 5 to 104 fathoms.

Dull chestnut brown, subtrigonal as a rule, but variable in outline, with 10 to 25 concentric ripples, sometimes obsolete near the ventral margin. When the ripples are few, prominent, and distant, we have the variety *latisulca* Hanley, 1843, of which perhaps *A. mortoni* Sowerby, 1874, is a mutation. This species was mistakenly identified with the European *A. sulcata* Da Costa by early American writers and by Jeffreys. A pale variety was named *A. lutea* by Perkins in 1869.

ASTARTE SUBÆQUILATERA Sowerby, 1854.

Davis Strait and southward, usually in rather deep water, along the eastern coast of the United States to the vicinity of Cape Florida, in 22 to 410 fathoms.

This species was named by Stimpson in manuscript *A. lens*, and this name, though never described, has found its way into the literature. Through Dr. Jeffreys it has also been confounded with *A. crenata* Gray and *A. crebricostata* Forbes, neither of which is closely related to it. The shell is ovate, compressed, pale or yellowish brown, the deep-water specimens sometimes nearly white, and it is sculptured with numerous even, low, concentric ripples, which are obsolete in the adult behind. Specimens reach a length of 39, with a height of 31 and a diameter of 10 mm.

ASTARTE (SUBÆQUILATERA var?) WHITEAVESII Dall, 1903.

Gulf of St. Lawrence and south to Long Island Sound, in 67 to 128 fathoms.

This, which is the *crebricostata* of Dawson,[a] has also been called *crenata* and *lens*, while I find it labeled by Jeffreys "*sulcata* variety *nana*," though it has no close resemblance to *sulcata* Da Costa. It resembles the young of *subæquilatera*, but is more convex; has the concentric sculpture continued to the margin behind, and is, on the whole, rather darker in color. It was dredged abundantly by Whiteaves at Gaspé, in 200 fathoms.

ASTARTE POLARIS Dall, 1903.

Polar Sea, dredged off Hare Island, Davis Strait, in 90 fathoms, and is also found near Bering Strait.

Plump, subtrigonal, with olive-brown periostracum, thin shell, deeply excavated lunule, and delicate hinge. The sulcation of the margin appears only with complete maturity. The concentric sculpture is fine, close, and low, sometimes degenerating into mere striation. Externally the shell recalls *Corbicula*.

ASTARTE CRENATA Gray, 1824.

Shannon fiord, East Greenland (as *crebricostata* Moebius); Prince Regent Inlet, Melville Island and adjacent waters (Parry); and south to the Gulf of St. Lawrence, in 16 to 200 fathoms.

Some of the specimens collected by the Parry expedition, from which Gray described the species, are fortunately in the Jeffreys collection and enable me to fix this species, which has also been named *A. oblonga* by Sowerby in 1854. It appears to be rare, and is a thin, inflated, elongate-oval shell, delicately, closely, concentrically striated or grooved, with the sculpture often obsolete below and stronger near the beaks. It is a smaller, thinner, and much more inflated shell than *subæquilatera*, and of a pale straw color or light brown color somewhat polished when in fine condition.

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[a] Can. Nat., 1872.

ASTARTE SMITHII Dall, 1886.

Gulf of Mexico, Cuba, Martinique, Barbados, and Campeche Bank, in 54 to 450 fathoms, bottom temperature 53° to 65° Fahr.

Shorter, more inflated, paler, and with ribs of a different shape from those of *subæquilatera* or *whiteavesii* of about the same size. It is sharply crenate, while the young of the other species referred to, at an equivalent growth, are usually without crenations. The species was named in the Blake report.

ASTARTE GLOBULA Dall, 1886.

Off Fernandina, Florida, in deep water, south to the coast of Cuba, and in the Gulf of Mexico, in 294 to 539 fathoms. One valve, perhaps drifted, in 1,568 fathoms.

Of the same general type as *A. smithii*, but perfectly smooth and attaining a larger size. The margin is sharply crenate and the color grayish white. It was at first supposed to be a smooth variety of *smithii*, but more material indicates that it is distinct.

ASTARTE NANA (Jeffreys MS.) Dall, 1886.

Cape Hatteras, North Carolina, and south to the Florida reefs and Sombrero Island, West Indies, in 6 to 227 fathoms; temperature, 51° Fahr.

This shell is somewhat larger and flatter than *A. smithii*, with more erect and prominent beaks, and the ribs cover the whole shell; it is crenate only when perfectly mature; the color varies from light yellow brown to rose pink. A still more convex and triangular form occurs among the specimens dredged in the Gulf of Mexico, and among the Florida reefs in 25 to 60 fathoms, which was labeled by Jeffreys variety *trigona*.

ASTARTE LIOGONA Dall, 1903.

Near the delta of the Mississippi River, in the Gulf of Mexico, at 118 fathoms, muddy bottom.

A single specimen of a small olivaceous species was dredged as above. It differs from all those hitherto known on the coast, by having the beaks and main part of the disk smooth, while near the margin are a few distinct narrow concentric ribs. The inner margin is sharply crenate.

Section TRIDONTA Schumacher.

ASTARTE ARCTICA Gray, 1824.

Vadsö, Norway; the Arctic Atlantic, Davis Strait, and Greenland, in 15 to 60 fathoms. Also near Bering Strait.

This convex and smooth form is well distinguished from the *A. borealis*, and is wholly destitute of concentric ribbing. It is a circumpolar

species and of a dark blackish brown color. It has very generally united with *borealis*, doubtless for want of a sufficient series for comparison. It is the *corrugata* and *depressa* of Brown, 1827; according to Sowerby, the *cyprinoides* of Duval, 1841; the *islandica* of Deshayes (MS.), 1867; the *lactea* and *subtrigona* of Sowerby, 1874. It is somewhat variable in outline, but the other characters are fairly constant.

ASTARTE BOREALIS Schumacher, 1817

Bennett Island, Polar Sea; North Europe and the Baltic, Arctic Atlantic, Iceland, and Greenland, and south to Massachusetts Bay, in 15 to 100 fathoms. Also Bering Sea and Strait, etc.

Shell compressed, with the beaks concentrically ribbed; the rest of the disk more or less smooth. This is the *semisulcata* of Leach, 1819; the *veneriformis* Wood, 1828; the *lactea* of Broderip and Sowerby, 1829. According to authors it is the *withami* of J. Smith, 1839; and *producta* Sowerby, 1874, is synonymous. The young have been named *richardsonii* by Reeve, in 1855; *placenta* (Mörch) and *rhomboidalis* Leche, Vega Exp., Lamellibranchiata, 1883.

ASTARTE ELLIPTICA Brown, 1827.

North Europe, Arctic seas near Greenland, and south to Massachusetts Bay, in 8 to 90 fathoms.

An elegantly ovate subcompressed shell, with rather low beaks, the upper half of the disk concentrically rippled, the lower part smooth or feebly striated. The color varies from warm yellow brown through chestnut to blackish. It is the *ovata* of Brown, 1827, the *garensis* of J. Smith, 1839, and the *intermedia* of Sowerby, 1854. It has sometimes been referred to *Venus compressa* Linnaeus, but this is a mere hypothesis, incapable of verification, and should be rejected.

ASTARTE QUADRANS Gould, 1841.

Gulf of St. Lawrence to Long Island Sound in 6 to 40 fathoms.

A small, smooth, compressed, quadrate species, which has not been characteristically figured. The inner surface of the shell is usually white, but sometimes dark colored. A specimen of this sort was named *A. portlandica* by Dr. Mighels in 1843. I find it labeled "*A. castanea* variety *nana*" by Jeffreys. It is not a common species.

ASTARTE ACUTICOSTATA Jeffreys and Friele, 1877.

Arctic Atlantic, in deep water, Jan Mayen and Novaia Zemlia, in 200 to 649 fathoms.

A small quadrate species, with fine, regular, well-marked, concentric ribbing all over the shell.

ASTARTE GLOBOSA Moller, 1842.

East and West Greenland, and adjacent Arctic waters, in 10 to 150 fathoms.

Small, blunt, ventricose, yellow brown, the anterior end longer, rounded, the posterior end subtruncate, the surface closely, finely, concentrically sulcate all over. The species was identified as *compressa* by Moebius, 1874, and Jeffreys called it *compressa* variety *striata*. It is one of three or four related forms fairly recognizable which have been usually "lumped" under one name. Nothing which can be properly identified with the British *A. compressa* is known from American waters.

ASTARTE FABULA Reeve, 1855.

Franz Josef Land to Greenland and adjacent Arctic waters in 12 to 90 fathoms. Also in the Polar Sea, near Bering Strait.

A thin elongate-ovate, inflated species, with the posterior end slightly longer, the umbonal region peculiarly, squarely, concentrically sulcate, and the basal portion striated. The color is usually dark brown. It was described by Sowerby in 1874, as *A. semilirata*, and has frequently been identified as *A. banksii*, but it is not *A. banksii* of Leach.

ASTARTE PULCHELLA Jonas, 1845.

Hogarth Sound, Cumberland Inlet, and adjacent Arctic waters, also Novaia Zemlia, in 5 to 10 fathoms.

Ovate, thin, polished; evenly, concentrically, elegantly sulcate, with narrow lanceolate lunule; the color light brown, and the beaks nearly central. It is the *A. warhami* Hancock, 1846.

ASTARTE BANKSII Leach, 1819.

Baffin's Bay and adjacent waters to lat. 80° N., also Spitsbergen, in 12 to 60 fathoms.

Mr. E. A. Smith has shown that the numerals of the figures of *striata* and *banksii*, Leach, in Beechey's Zoology of the Voyage of the Blossom, are exchanged and the figure formerly referred to *striata* represents *banksii* and *vice versa*. This confusion runs through much of the literature. Specimens of *A. banksii*, which is a nearly smooth species of a reddish brown or olivaceous tint, were labeled *compressa* variety *striata* by Jeffreys.

ASTARTE STRIATA Leach, 1819.

Baffin's Bay, Davis Strait, and adjacent waters, and south to the Grand Banks, the Gulf of St. Lawrence, and Massachusetts Bay, in 10 to 85 fathoms.

Subtrigonal, with somewhat coarsely sulcate umbonal region, the

ventral margin in the adult merely striated. It is the *banksii* of many authors and is figured under that name in Binney's Gould, 1870, and regarded as a variety of *A. compressa* by Jeffreys.

ASTARTE (LAURENTIANA Lyell, 1845, var.?) SOROR Dall.

Type in the Leda clays and other Pleistocene beds of eastern Canada and New England; variety *soror*, from 82° north latitude through the Arctic waters southward to the Gulf of St. Lawrence in 5 to 90 fathoms.

The recent shell is more trigonal, larger, and the concentric sculpture coarser than that of the typical Pleistocene fossil. I adopt the above varietal name for the recent form until more is known, but I suspect the species are distinct.

LIST OF THE SPECIES OF THE WESTERN COAST.

ASTARTE POLARIS Dall, 1903.

Kyska Harbor, Aleutians; Constantine Harbor, Amchitka; and near the Shumagin Islands, in 10 to 58 fathoms, mud or sand, bottom temperature 41° to 45° F. Also in Baffin's Bay, on the Greenland coast.

This is the only typical *Astarte* so far identified on the northwest coast.

ASTARTE LONGIROSTRA D'Orbigny, 1847.

Falkland Islands, D'Orbigny; Straits of Magellan, in 20 to 61 fathoms, bottom temperature 48° F.

The *A. magellanica* Smith, 1881, judging from the specimens dredged by the U. S. Fish Commission steamer *Albatross*, varies so that the distinctions relied on to separate it from *A. longirostra* disappear in a good series. The name *magellanica* might, however, be retained in a varietal sense for the specimens with more pronounced sculpture and less protracted beaks. This is the only species recorded from the southern hemisphere.

Section TRIDONTA Schumacher.

ASTARTE ROLLANDI Bernardi, 1858.

Avatcha Bay, Kamchatka, and eastward through the Aleutian and Pribilof Islands, and along the Alaskan coast to Prince William Sound, in 8 to 27 fathoms.

Suborbicular, nearly smooth, large and heavy, with dark chestnut brown periostracum, which in the adults is dehiscent on drying. This species takes the place in the western fauna occupied by *A. castanea* on the eastern coast, and, like it, has a pale oblique variety ([illegible] Dall, 1903), which is found on oceanic islets, Chika, the Semidis, and Middleton, in 12 to 25 fathoms, sand.

ASTARTE ARCTICA Gray, 1824.

Bering Strait, Bering Sea, and the Aleutian Islands from Attu to Unalga Pass east of Unalaska in 15 to 60 fathoms; also in the eastern arctic waters.

See the eastern list for synonymy and further data.

ASTARTE BOREALIS Schumacher, 1817.

Polar Sea, near Bennett Island; *Jeannette* expedition. Macfarlane Bay, near the mouth of the Mackenzie; Bering Strait and southward on the American side to Port Etches, Prince William Sound, and on the Asiatic side to Yokohama.

For synonymy, etc., consult the eastern list. The variety *rhomboidalis* Leche, 1883, as figured, is based on an immature specimen, while the variety *placenta* Mörch is simply the young shell of the normal type. A somewhat elongated specimen figured under the name of *A. scotica* by Middendorff, Plate XVI, figs. 10–12, 1849, may be the young of this species or an unusually strongly ribbed *elliptica*. He gives localities from Lapland to the Okhotsk Sea. The latter were probably *borealis;* the former might have been *elliptica*. His figures on Plate XVII of the same name are probably *A. sulcata*. Figs. 6 to 7 on the same plate under the name of *corrugata* Brown are probably *A. borealis*; figs. 4, 5, 8, 9, and 10, perhaps, are dilapidated *A. rollandi*. In the Sibirische Reise, Plate XX, figs. 1 to 4, 1851, which are named *A. scotica*, represent *A. borealis*, and it is evident he regarded the two as synonymous. *A. compressa*, on the other hand, he does not record from eastward of the Taimyr River. The Macfarlane Bay specimens are exceptionally smooth, compressed, and thin.

ASTARTE ALASKENSIS Dall, 1903.

Southern part of Bering Sea, the vicinity of the Shumagin Islands, and eastward along the Alaskan coast and south to Puget Sound in 10 to 70 fathoms. Also in the glacial drift of Sucia Island, Straits of Georgia.

Much resembling *A. elliptica* of the eastern coast, but shorter, heavier, and more trigonal. The periostracum is black or dark brown and dehiscent when dry. It has usually been identified as *undata* but is never crenulated.

ASTARTE COMPACTA Carpenter, 1865.

Puget Sound, Kennerley, and Johnson.

Small, stout, trigonal, like *A. esquimalti*, but with regularly arcuate, uniform concentric ribbing. It was described as a variety of *A. compressa* Montagu, which does not occur on the coast. It appears to be rare, and I have seen only one specimen beside the type. The former is figured, Plate LXIII, fig. 8.

ASTARTE FABULA Reeve, 1855.

Polar Sea, near Point Belcher, and south to the north end of Nunivak Island in 15 to 23 fathoms. Also in the eastern hemisphere at Franz Josef Land, the coast of Greenland, etc.

Leche's figures of "*A. warhami*" in his report on the Vega lamellibranchs indicate that he probably included this species under that name. *A. semilirata* Sowerby, 1874, is synonymous. For other data see eastern list.

ASTARTE BENNETTII Dall, 1903.

Polar Sea at Bennett Island, *Jeannette* expedition; also in Bering Sea, 5 miles west of Nunivak Island, in 24 fathoms, Dall.

Small, solid, rather uniformly concentrically striate; polished, olivaceous, with high beaks. Leche's figures 11 and 12, Plate 32, may have been taken from a specimen of this species, with the posterior end rather blunter than usual, and not full grown. In the Bering Sea specimen the striation is stronger near the beaks.

ASTARTE VERNICOSA Dall, 1903.

Arctic Sea and northern part of Bering Sea, from Icy Cape to Hagemeister Island, in 7 to 28 fathoms, and southern part of Bering Sea, through the Aleutians from Attu to Atka, in 8 to 14 fathoms.

Resembling *A. fabula*, but more coarsely and uniformly sulcate and brilliantly polished, with an olivaceous yellow-brown periostracum, narrower, longer, and less impressed lunule.

Leche's figures 7 to 8, Plate 32, apparently represent this species.

Section RICTOCYMA Dall.

ASTARTE ESQUIMALTI Baird, 1863.

Aleutian Islands from Unalaska eastward along the coast of Alaska and south to Puget Sound in 6 to 80 fathoms.

Recognizable by its irregular sculpture, and reaching a height of 21, with a length of 23 and a diameter of 11 mm. *R. mirabilis* Dall, 1872, was based on a young specimen of this species.

DESCRIPTIONS OF THE FORMS NEWLY NAMED.

ASTARTE POLARIS, new species.

Plate LXIII, fig. 5.

Shell rounded-trigonal, moderately thick, bluish white, covered with a slightly polished light-brown periostracum; valves moderately convex, with the umbones high, somewhat prosogyrate, over a well impressed lanceolate lunule, which is unequally divided, the right valve bearing the larger share; escutcheon narrower and longer than the lunule, impressed, smooth; sculpture of forty or more small, narrow, regular,

concentric riblets separated by about equal interspaces; in the adult the posterior slope and ventral third of the disk have the riblets replaced by somewhat uneven concentric striation; interior smooth, the inner margins finely evenly crenate; hinge rather solid, the middle cardinal in each valve grooved or bifid. Height, 25; length, 28; diameter, 15 mm.

The type specimen, No. 106859, is from 51 fathoms, sand, near the Shumagin Islands, Alaska. The nearest form to this is *A. sulcata* var. *multicostata* Jeffreys, which in form and outline approaches it very closely, but differs by sparser ribbing, which is also more regular and extends over the whole shell.

ASTARTE ALASKENSIS, new species.

Plate LXIII, fig. 2.

Shell ovate, subcompressed, white, with a dark, strong, caducous periostracum, which, like that of *A. elliptica*, becomes black in the dead or senile shells; valves quite inequilateral, beaks at the anterior third, elevated, slightly compressed, prosögyrate; lunule excavated, sublanceolate, the escutcheon longer and wider; sculpture of about a dozen concentric riblets with wider interspaces, more feeble near the ventral and posterior margins; inner margins entire, smooth; hinge solid, the teeth narrow and entire. Height, 26; length, 31.5; diameter, 14 mm.

Type specimens from northwest of Unimak Island, in the southern part of Bering Sea, at a depth of 70 fathoms; bottom temperature 39° F. U.S.N.M., No. 109274.

ASTARTE BENNETTII, new species.

Plate LXIII, fig. 6.

? *Astarte warhami* LECHE, Vega exped., III, 1883, p. 442, pl. XXXII, figs. 11 and 12 (only).

Shell small, thin, subcuneate, subcompressed, with a polished olivaceous periostracum; posterior end shorter, bluntly rounded; anterior end longer, more sloping and direct dorsally, rounded; base nearly straight in the young; surface finely concentrically striate, or nearly smooth, the striæ more apparent on the beaks; lunule narrow, lanceolate, impressed, escutcheon similar, a little longer than the lunule; beaks high, slightly prosogyrate; hinge delicate, the large cardinals slightly grooved above, the laterals apparent; pallial line rather near the margin, which is not crenulate. Height 10.5, length 11.5, diameter 5.0 mm.; Bering Sea specimen height 14.5, length 15.0, diameter 7.0 mm.

In the terrible retreat from the Jeannette over the arctic floes Mr. Newcombe, the naturalist of the expedition, retained a small packet

containing a few specimens of natural history from the most northern land reached, Bennett Island. Among these were a fragment of *Astarte borealis* and a single perfect specimen of the present species, U.S.N.M., No. 83221. A single other specimen was obtained by me within the limits of the arctic fauna in the northern part of Bering Sea, in 24 fathoms. Leche's figure is slightly more oblique and convex, but very probably represents the same species.

ASTARTE (LAURENTIANA var.?) SOROR, new species.

Plate LXII, fig. 11.

Shell of moderate size, subequilateral, rounded-trigonal or cytheræiform, the beaks moderately elevated, full and prosogyrate; the anterior end slightly shorter, the lunule rather small, lanceolate and impressed, the escutcheon similar but longer; surface covered with fine, rather harsh concentric sulci with subequal interspaces, very uniform over the surface; periostracum dull, of a dark brown color, sometimes paler or olivaceous in the young; hinge delicate, laterals distinct, large cardinals sulcate or striated above; inner margins entire. Height 18.0, length 21.5, diameter 10.0 mm.

This species differs from *A. fabula* by the sculpture of its umbones and the sulcation of the whole disk externally; it has the same kind of sculpture as *A. laurentiana* but coarser and more harsh to the touch; the form in general is more trigonal or rounded than in *A. laurentiana*, but this is variable and some specimens agree well in shape. *A. polaris* is distinguished by deeper excavation of the lunule, smoother and more open sculpture, and the crenation of the inner margins.

This is the species of which young individuals have been taken for recent specimens of *A. laurentiana*, but which I am inclined to regard as distinct, especially since no fossil *laurentiana* approach it in size. Jeffreys included it, with a number of other things which appear to me distinct, under the name of *A. compressa* var. *striata*. The type locality is Godhavn Harbor, Disco Island, Greenland. U.S.N.M., No. 109278.

The typical *A. laurentiana* was described by Lyell in his Travels in North America in 1845. In the American edition, published the same year, it can be found figured, page 125, figs. 15a–15c, and described on page 126 of the second volume, a reference which I had some difficulty in finding and which was kindly supplied by Dr. Whiteaves. It is found in the Pleistocene clays of the St. Lawrence Valley.

[a] The other molluscan specimens included egg cases of *Bela* sp., *Chrysodomus* sp., and *Natica* sp., and fragments of *Liocyma fluctuosa* Gould, *Modiolaria nigra* Gray, and *Yoldia abyssicola* Torell; U.S.N.M., Nos. 83220–83227.

ASTARTE SUBÆQUILATERA var. WHITEAVESII Dall.

Plate LXII, figs. 7, 12.

Shell rounded quadrate, plump, inequilateral, the anterior end shorter; concentrically sculptured with 20 to 25 sharply defined rounded ribs with wider channeled interspaces, the ribs continuous over the whole shell; periostracum thin and papery, of a pale yellowish brown; lunule and escutcheon smooth, lanceolate, moderately impressed; inner margins, when adult and at resting stages, crenate, hinge strong, the cardinals entire. Height 12, length 14.5, diameter 6.5 mm.

Type locality, Gaspé, Whiteaves, in 200 fathoms. U.S.N.M., No. 95748.

The continuous ribs behind, more convex valves, and smaller size distinguish this variety from the typical *subæquilatera* of Sowerby or the *lens* of Stimpson.

ASTARTE LIOGONA, new species.

Plate LXII, fig. 9.

Shell small, compressed, rounded trigonal, beaks erect, somewhat eroded in the type, umbonal region (outside of the eroded tract) smooth or marked only with incremental lines, but near the base there are indications of five narrow rounded concentric ribs, with wider interspaces; periostracum olivaceous, rather dark; lunule lanceolate, moderately impressed, smooth; escutcheon narrower and longer; ligament short; hinge moderately strong, the teeth entire, inner margins strongly crenulate. Height 7.0, length 7.5, diameter 4.0 mm.

Dredged in 118 fathoms, near the delta of the Mississippi, on a muddy bottom. U.S.N.M., No. 64434.

If this specimen is characteristic it differs from any other known to me in having the umbonal region smooth, while the peripheral portion exhibits raised ribbing.

ASTARTE VERNICOSA, new species.

Plate LXIII, fig. 1.

Astarte warhami (Hancock) LECHE, Vega exped., III, 1883, pl. XXXII, figs. 7–8 (only) 1883.

Shell small, subcompressed, subtrigonal, subequilateral, covered with a brilliantly polished olivaceous brown periostracum; beaks rather high, slightly prosogyrate, the lunule narrow, lanceolate, impressed, the escutcheon similar but longer; base arcuate, anterior end rounded, posterior end slightly more produced; hinge delicate, inner margins smooth, hinge teeth much as in *A. bennettii*. Length 17.0, height 15.0, diameter 6.7 mm.

Type locality, off Icy Cape in 15 fathoms sand, W. H. Dall. U.S.N.M., No. 109276.

Our specimens are somewhat more trigonal and attenuated behind than in Leche's figures. The sculpture is of quite even and regular sulcations which usually are somewhat less pronounced on the ventral third of the disk, but never present the striking contrast between the sulcate and unsulcate portions which may be usually noted in *A. fabula*. In many cases, however, the sculpture is continued to the base without obsolescence, almost as evenly as in Hancock's *warhami*, but the shape of the valves is different and the present species is much less inflated. Leche's figures 9 and 10 appear to represent *A. fabula*, of which occasional specimens are sulcate clear to the base, but which can usually be recognized by the squarish and slightly wavy appearance of the concentric umbonal sculpture.

ASTARTE (RICTOCYMA) ESQUIMALTI Baird.

Plate LXIII, figs. 11, 12.

This species having been figured only imperfectly, better figures are now supplied from an adult specimen (U.S.N.M., No. 106862), dredged near the Shumagin islands in 58 fathoms.

VENERICARDIA CRASSIDENS Broderip and Sowerby.

Plate LXIII, fig. 9.

Astarte crassidens Broderip and Sowerby, Zool. Jour., IV, 1829, p. 365.

Icy Cape, Belcher, in Bland's collection (Broderip and Sowerby.)

This species is described as "obsoletely radially sulcate," much eroded at the umbones, with a large striated cardinal in either valve and with the margins coarsely crenulate, the crenulations having "almost the appearance of low embrasures." It is represented as reaching a length of 40, a height of 41, and a diameter of about 21 mm., with a tinge of dull reddish purple in the center of the valves inside and the umbones nearly terminal and anteriorly directed.

Now, these characteristics are not those of an *Astarte*. All our Arctic Astartes are white within; none is radiately sulcate; none has embrasure-like crenations. Moreover, the vicinity of Icy Cape has been pretty well dredged at various times, and *Astarte* is a gregarious genus. If a species with such striking characteristics appeared there somebody would have been almost certain to recover it. But no specimen is known, nor what became of that one which served as the type from "Mr. Bland's" collection.

There is a shell which has been more than once obtained at Icy Cape which fulfills the requirements, and that is the species of *Venericardia* identified by Gray with "*Arcturus rudis*" (Humphrey Ms.) in 1839. The radial sulcation, except on the umbones (which our authors dat-

were much eroded), is often obsolete, its beaks nearly anterior, its hinge broad, its margin with embrasure-like flutings, and it frequently has the disk tinged inside with a flush of livid purple-brown. I have in my Synopsis of the *Carditacea* called this *Venericardia rudis*, but I am now almost convinced that it is the present shell and should take the name of *V. crassidens*. It has the very markedly broad hinge and large, more or less sulcate cardinals called for by the description, and one of the specimens in the National Museum comes within 2 millimeters of the required dimensions. Mr. Smith has referred this to *Astarte castanea*, but *A. castanea* does not occur in that region, and has quite small though very distinct crenations, which have not the square form recalling embrasures like those of *Venericardia*. Nor does *A. castanea*, as far as known, reach a size comparable with that mentioned for *A. crassidens*. All the other Astartes known from the region where Icy Cape is situated which are large enough to fill the requirements of the diagnosis of Broderip and Sowerby have very white shells and perfectly smooth margins. There is only one crenate species there, and it is quite small in comparison and has quite minute crenulations.

The European species which do not appear in the Western Hemisphere are *Astarte sulcata* Da Costa, *A. incrassata* Brocchi (frequently called *A. fusca* Poli), *A. cribricostata* Forbes, *A. compressa* Montagu, *A. pusilla* Forbes, *A. parva* Searles Wood, *A.* (*Gonilia*) *calligona* Dall (*A. bipartita* Philippi non Sowerby), *A.* (*Digitaria*) *digitaria* Linnæus, *Goodallia triangularis* Montagu, and *G. macandrewi* Smith. *Astarte triquetra* Conrad is a *Parastarte* and belongs in the *Veneridæ*; *A. flabella* Conrad, is a *Venericardia*, and *A. fluctuata* Carpenter, is the nepionic young of *Crassatellites* sp.

Since the figures of the new species do not wholly fill the plates, the figures of some recently described but yet unfigured species are included with those of the Astartidæ, with references to the place of publication.

EXPLANATION OF PLATES.

Plate LXII.

Fig. 1. *Crania patagonica* Dall, upper valve, diameter 8.5 mm.; Proc. U. S. Nat. Museum, XXIV, 1902, p. 562; Straits of Magellan, U. S. N. M., No. 96913.

2. *Crassatellites brasiliensis* Dall, from off Rio de Janeiro in 59 fathoms; lon. 37 mm.; U. S. N. M., No. 96104; The Nautilas, XVI, p. 101, 1903.

3. *Crania patagonica* Dall, inner face of upper valve showing muscular impressions.

4. *Crenella megas* Dall, height 25 mm.; Proc. U. S. Nat. Mus., XXIV, 1902, p. 559; Panama Bay, in 33 fathoms; U. S. N. M., No. 96256.

5. *Echinochama californica* Dall, new species, from off Cerros Island, Lower California, in 25 fathoms; length exclusive of the spines, 40 mm.; U. S. N. M., No. 96452. The coloration is yellowish white.

Fig. 6. *Venericardia armilla* Dall, length, 8 mm.; from the Gulf of Mexico; U. S. N. M., No. 93374; Proc. Acad. Nat. Sci. of Philadelphia for 1902, p. 713.

7. *Astarte subæquilatera* Sowerby, var. *whiteavesii* Dall, umbonal view; length, 15 mm.; Gaspé, Gulf of St. Lawrence in 200 fathoms; U. S. N. M., No. 95748; p. 948.

8. *Limopsis panamensis* Dall, length, 6 mm.; Gulf of Panama in 1,030 fathoms; U. S. N. M., No. 109028; Proc. U. S. Nat. Mus., XXIV, 1902, p. 559.

9. *Astarte liogona* Dall, length 7.75 mm.; Gulf of Mexico; U. S. N. M., No. 64439; p. 948.

10. *Venericardia moniliata* Dall, length, 6.5 mm.; off Rio de Janeiro in 59 fathoms; U. S. N. M., No. 96132; Proc. Acad. Nat. Sci. of Philadelphia, for 1902; p. 713.

11. *Astarte soror* Dall; length, 19 mm.; Greenland; U. S. N. M., No. 109278; p. 947.

12. *Astarte subæquilatera* Sowerby, var. *whiteavesii* Dall; lateral view, length, 15 mm.; U. S. N. M., No. 95748; p. 948.

13. *Cetoconcha scapha* Dall, length, 13 mm.; Gulf of Panama in 100 fathoms; U. S. N. M., No. 109026; Proc. U. S. Nat. Mus., XXIV, p. 561, 1902.

PLATE LXIII.

Fig. 1. *Astarte vernicosa* Dall, length 17.5 mm.; Icy Cape, Polar Sea; U.S.N.M., No. 109276; p. 948.

2. *Astarte alaskensis* Dall, length 29 mm.; Bering Sea; U.S.N.M., No. 107274; p. 946.

3. *Venericardia gouldii* Dall, length 17 mm.; off San Diego in 823 fathoms; U.S.N.M., No. 109270; Proc. Acad. Nat. Sci. Philadelphia for 1902, p. 714.

4. *Venericardia incisa* Dall, length 9.5 mm.; Unalaska; U.S.N.M., No. 109267; Proc. Acad. Nat. Sci. of Philadelphia for 1902, p. 714.

5. *Astarte polaris* Dall, length 28 mm.; Bering Sea; U.S.N.M., No. 106859; p. 945.

6. *Astarte bennettii* Dall, length 15 mm.; Bering Sea; U.S.N.M., No. 109279; p. 946.

7. *Venericardia alaskana* Dall, length 36 mm.; Nunivak Island, Bering Sea. U.S.N.M., No. 109271; Proc. Acad. Nat. Sci. Philadelphia for 1902, p. 710;

8. *Astarte compacta* Carpenter, length 13.5 mm.; Puget Sound; U.S.N.M., No. 129118; Proc. Acad. Nat. Sci. Philadelphia for 1865, p. 57.

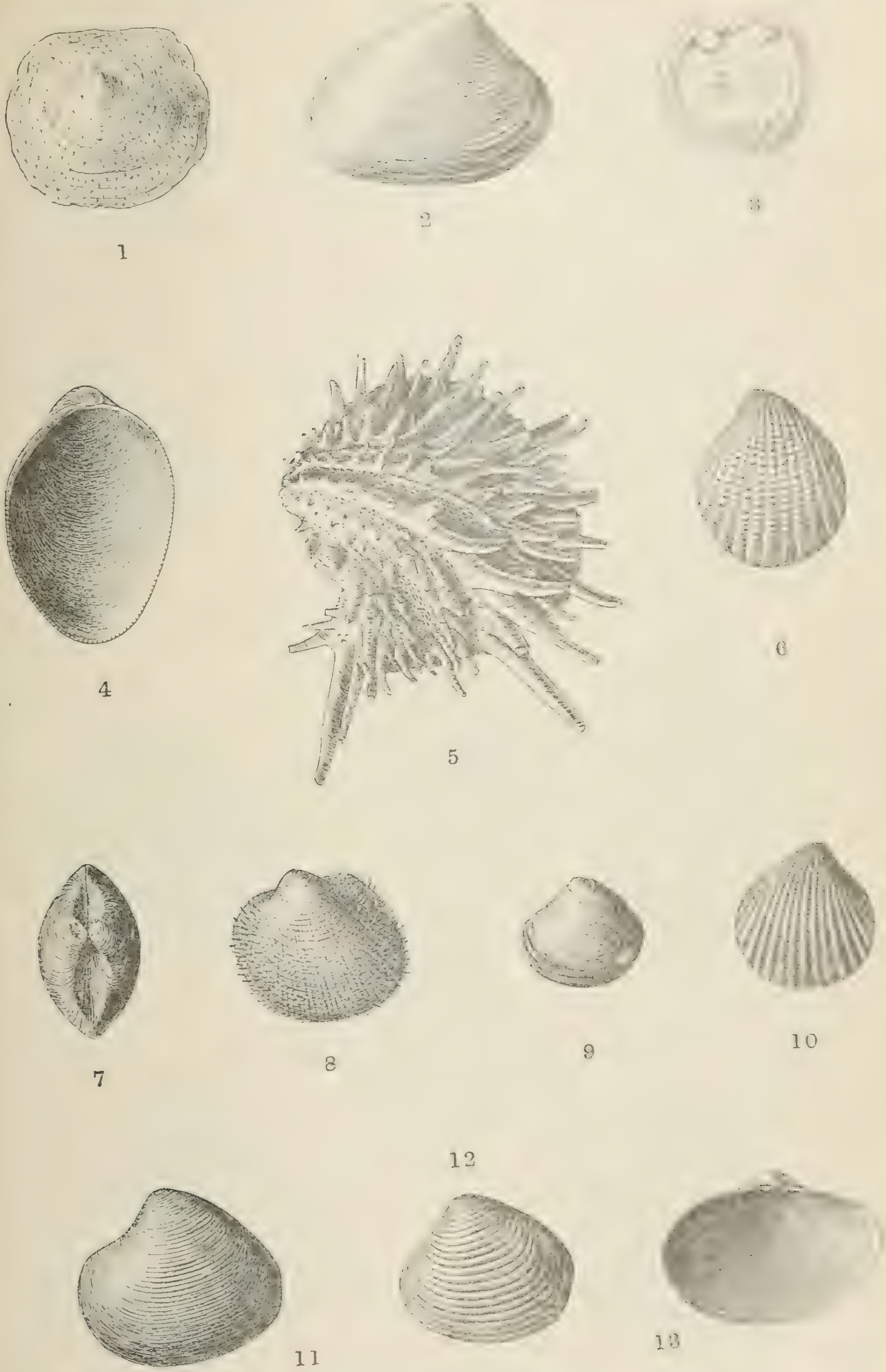
9. *Venericardia crassidens* Broderip and Sowerby (*V. rudis* Gray), length 31 mm.; Kyska Island, Aleutian chain; U.S.N.M., No. 109273; p. 949.

10. *Venericardia ventricosa* Gould, interior of right valve; length 18.5 mm.; California; Proc. Acad. Nat. Sci. Phila., for 1902, p. 709.

11. *Astarte* (*Rictocyma*) *esquimalti* Baird, length 15 mm., showing peculiar sculpture; from off Alaska Peninsula; U.S.N.M., No. 106862; p. 949.

12. Another valve of the same species; p. 949.

NOTE.—In the synopsis of the Carditacea, in Proc. Acad. Nat. Sciences of Philadelphia for 1902, p. 700, the name *Miodon* Carpenter, 1864, was adopted for a subgenus of *Veneri cardia*. It appears that this name was used by Dumeril for a fish before it was proposed by Carpenter for the mollusk, and I have therefore proposed for Carpenter's *Miodon* the new name *Miodontiscus*. For the section of *Terebra*, commonly called *Acus*, also a preoccupied name, I now suggest the designation of *Oxymeris*.



AMERICAN PELECYPODA.

FOR EXPLANATION OF PLATE SEE PAGES 950, 951.

ASTARTE AND VENERICARDIA.

FOR EXPLANATION OF PLATE SEE PAGE 953.

AN ALASKAN CORYMORPHA-LIKE HYDROID.

By Samuel Fessenden Clarke,
Professor of Natural History, Williams College, Massachusetts.

In a report on the hydroids of Alaska, published by the Academy of Natural Sciences in Philadelphia in 1876, the material of which was collected by parties under the charge of William H. Dall, and is now deposited in the United States National Museum, I created the family Rhizonemidæ, provisionally, and the genus *Rhizonema* for two somewhat mutilated specimens. Upon further examination, and with opportunity to consult a wider range of hydroid literature, I find that I was in error. The specimens belong either to the genus *Corymorpha* or to the genus *Lampra*, but they are not sufficiently well preserved to determine whether the gonophores are of the medusoid type characteristic of *Corymorpha*, or of the pseudomedusoid type of *Lampra*. The hydrocaulus is smallest just below the hydranth, enlarging gradually to near the base, where the basal filaments begin, and then tapers rapidly to a small rounded end; a small section of the stem immediately above the filaments is roughened with transverse wrinkles. The membrane which bears the filaments has something of a mammillated surface and is easily freed from the cone-shaped base, see figs. 1, 2. The hydranth is large; the proximal tentacles are in a single verticil; the distal tentacles are short, very numerous, matted together, and I can discover in them no regular arrangement. The proboscis is very large, being but slightly smaller at the distal than at the proximal end; the mouth is correspondingly large, the full width of the distal end of the proboscis. Immediately above the proximal tentacles are the peduncles of the gonophores; they are about thirty in number, and besides those forming the circle there are a few which originate a little higher up on the proboscis. The peduncles vary much in length in this imperfect, alcoholic specimen; they bear irregular clusters of processes, the gonophores, figs. 1, 3. These specimens were collected in Norton Sound, near St. Michael, Alaska, October 17, 1875, by L. M. Turner, of the U. S. Signal Service, who writes that "these specimens were of

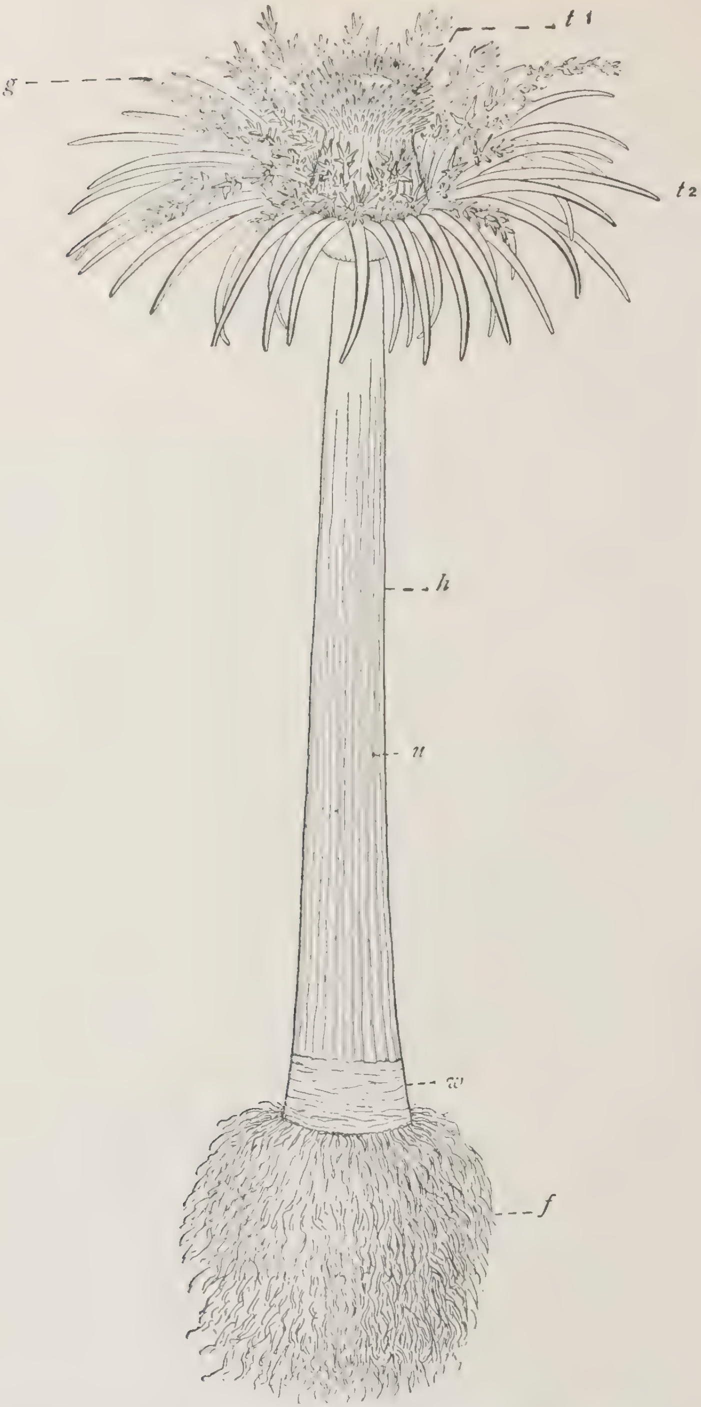


FIG. 1.—A RESTORATION OF THE BETTER SPECIMEN; ENLARGED TWO DIAMETERS.

f. Filaments.
g. Gonophores.
h. Stem.
t[1]. Distal tentacles.
t[2]. Proximal tentacles.
n. Canals in the cœnosarc.
w. Wrinkled area.

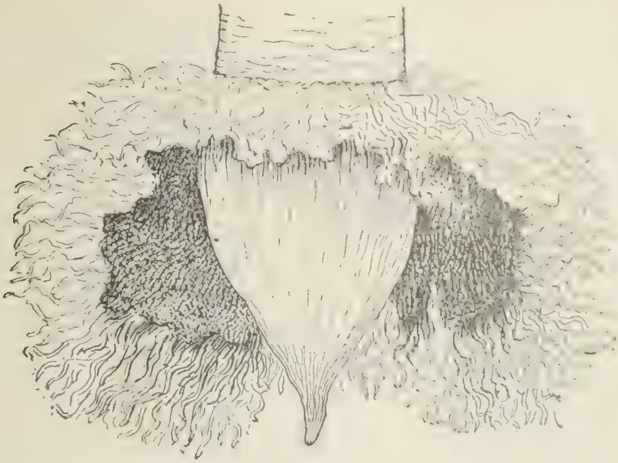


FIG. 2.—THE BASAL PART OF THE STEM, WITH THE FILAMENT MEMBRANE PARTLY TORN AND PULLED ASIDE.

FIG. 3.—A CAMERA OUTLINE OF ONE OF THE PEDUNCLES OF THE GONOPHORES.

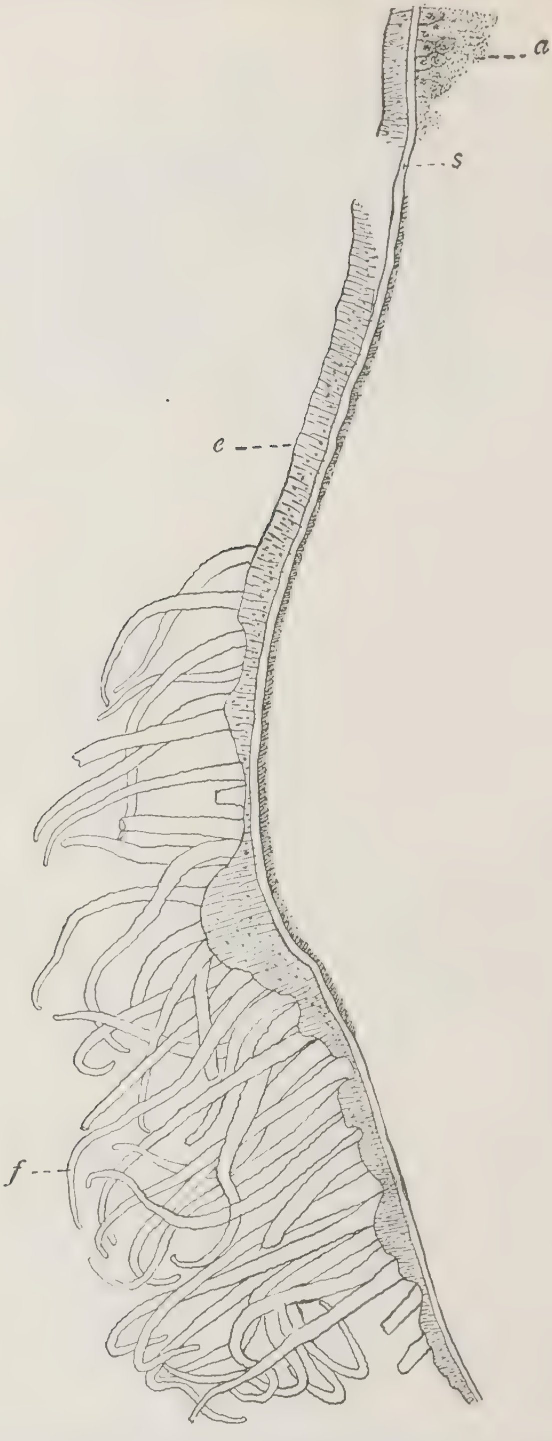


FIG. 4.—A LONGITUDINAL SECTION THROUGH THE STEM WALL NEAR ITS BASE. *a*, ENDODERM; *e*, ECTODERM; *f*, FILAMENT; *s*, SUPPORT-LAMELLA.

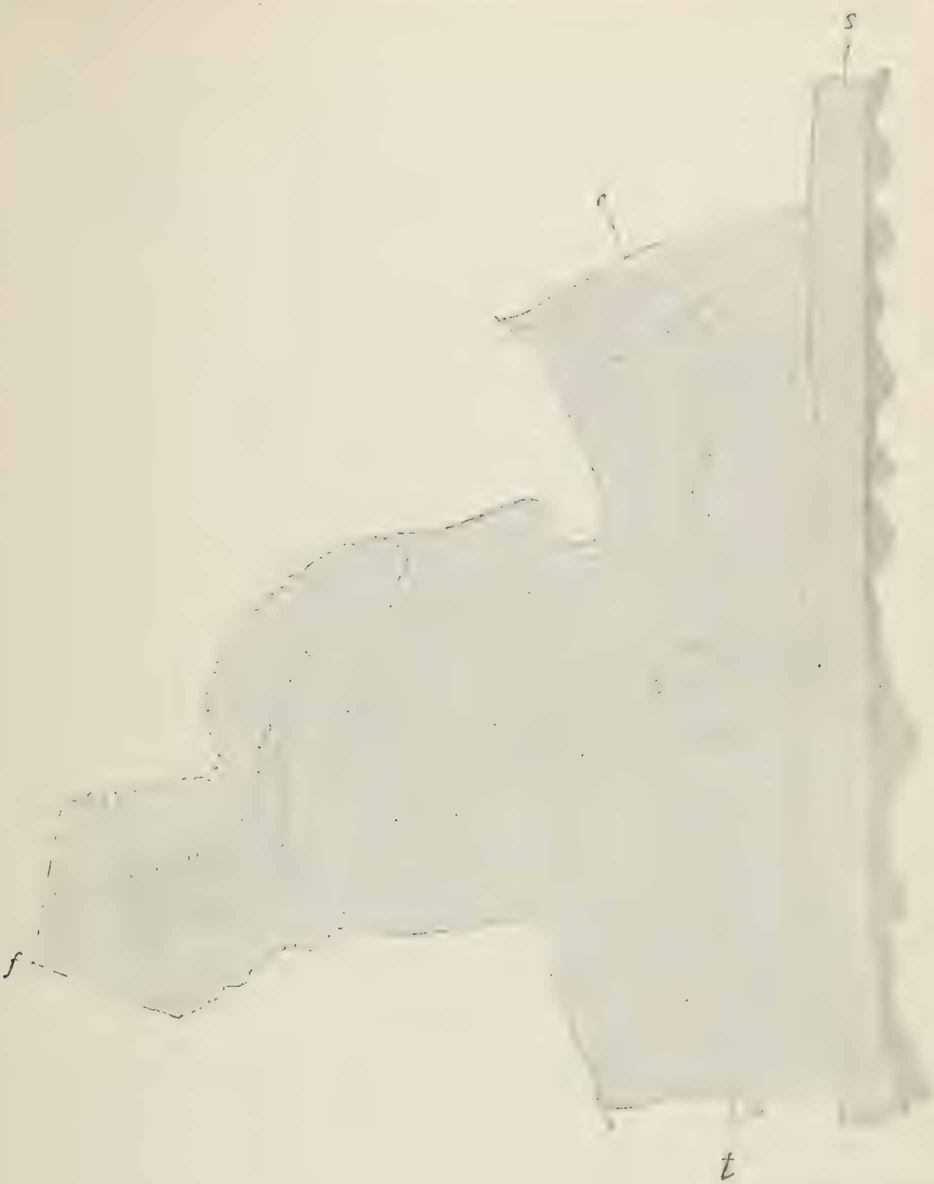


FIG. 5.—A PORTION OF FIG. 4 MORE HIGHLY MAGNIFIED; *t*, NEMATOCYSTS. FOR OTHER LETTERING SEE FIG. 4.

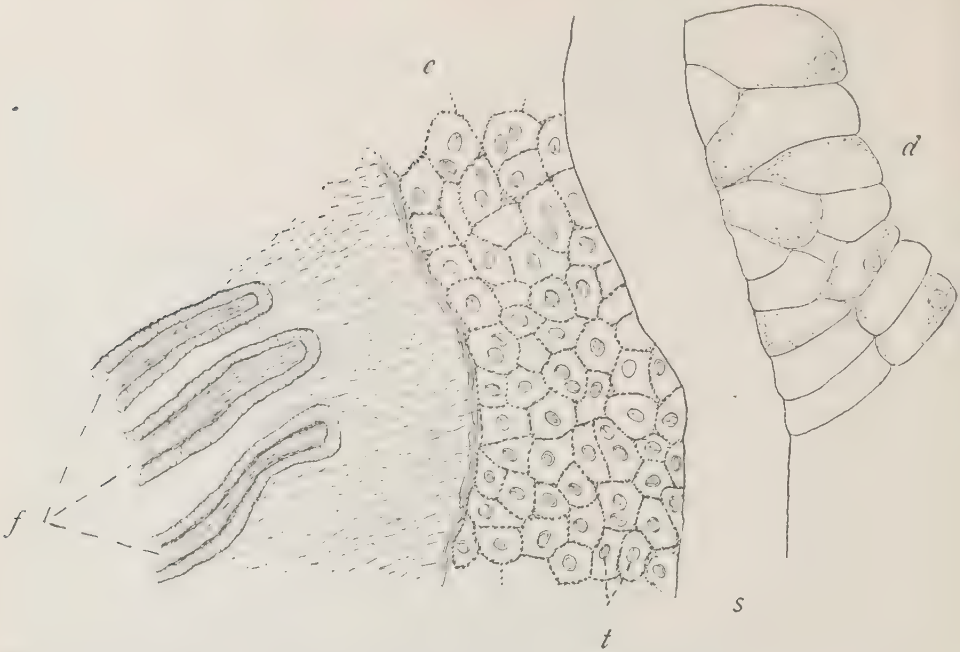


FIG. 6.—PART OF SECTION THROUGH THE BASAL PART OF A STEM OF CORYMORPHA PENDULA FROM WOODS HOLE; *d*, ENDODERM. FOR OTHER LETTERING SEE FIGS. 4, 5.

a deep coral red when found; they are not common." One of the specimens is complete, though it is somewhat mutilated, the tentacles and the sexual peduncles having suffered especially. The second specimen has no hydranth. An interesting structural feature is discovered in sections of the stem in the form of an unusually thick support-lamella, the Stützlamella of Reichert; it stains readily, and is found between the ectoderm and endoderm, well marked, in all parts of the stem. Sections through the basal part of the stem show many thread cells in the ectoderm, also the relation of the filaments to that layer. The filaments show no signs of cellular structure and are evidently developed from the ectoderm, fig. 5. There is but little left of the endoderm; a remnant of it is seen in fig. 4, *a*. Sections of the hydrocaulus of *Corymorpha pendula*, figs. 6, 7, show a simular thick support-lamella between the ectoderm and the endoderm. In the filament-bearing part there are many thread cells as in the Alaskan form, and farther up the hydrocaulus all three layers decrease in thickness. While this is probably a species of *Corymorpha*, I do not believe in rechristening it until we know definitely as to its genetic relations.

FIG. 7.—A PORTION OF THE SAME SECTION AS FIG. 6, BUT A LITTLE HIGHER UP ABOVE THE REGION OF THE BASAL FILAMENTS.

ON SOME NEGLECTED GENERA OF FISHES.

By Theodore Gill,
Honorary Associate in Zoology.

Dr. Charles W. Richmond recently purchased a serial in twelve volumes entitled Magazin für das Neueste aus der Physik und Naturgeschichte, published in Gotha from 1781 to 1799, and kindly called my attention to it. In the sixth volume (3. Stück, pp. 28–38) for 1790 is an outline of a division of fishes according to their teeth (Versuch einer Eintheilung der Fische nach den Zähnen) by Hein[rich] Fr[iedrich] Linck, in which several generic names are proposed which take precedence of some in general use, but happily do not otherwise seriously disturb the nomenclature. Linck is only known by the article in question, which is duly recorded in the Bibliotheca Zoologica of Carus and Engelmann (p. 971), and by a prize writing: De analysi urinæ et origine calculi, referred to by the editor of the Magazin.

As the magazine is very rare, an outline of the classification seems to be desirable, although there is nothing of value in it and characters are often erroneously given and misapplied.

CLASSIFICATION.

1. Ordnung. Zähne in beiden kinladen [sic!] allein, ohne Unterschied der Vorder- und Backenzähne.
   - *a.* Ohne Kiemendeckel.
     Squalus, Mustelus (p. 31), Pristis (p. 31), Raja, Rhinobatos (p. 32).
   - *b.* Mit Kiemendeckeln.
     Blennius, Cobitis, Callichthys (Silurus Linn.), Caepala [=Cepola], Teuthys [=Teuthis], Zeus, Pleuronectes, Chaetodon, Acanthurus, Gasterosteus, Exocoetus, Sternoptyx.
2. Zähne in den Kinnladen und im Gaumen, Vorder- und Backenzähne sind nicht verschieden (p. 33).
   Muraena, Gymnotus, Silurus, Trachinus, Cottus, Amia, Polynemus, etc., etc.

3. Zähne in den Kinnladen, auf der Zunge und im Gaumen. Vorder- und Backenzähne sind nicht verschieden (p. 34).
   Lophius, Uranoscopus, Salmo, Esox, etc., etc.
4. Zähne in den Kinnladen und im Gaumen. Die Vorderzähne sind von den Backenzähnen verschieden (p. 35).
   Anarrchichas [Anarrhichas], Sparus, Labrus, Perca.
5. Zähne in den Kinnladen allein. Die Vorderzähne sind von den Backenzähnen verschieden.
   Chimaera, Balistes, Ostracion, Mormyrus, Trichiurus?
6. Zähne in den Kinnladen und den Lippen (p. 36).
   Atherina.
7. Zähne in den Lippen und auf der Zunge.
   Petromyzon.
8. Zähne in der Oberkinnlade allein.
   Pegasus.
9. Keine Zähne.
   A. Das Maul ist in einen langen Rüssel vergezogen.
      Xiphias, Acipenses [Acipenser], Syngnatus [Syngnathus], Centriscus, Fistularia, Loricaria (p. 37).
   B. Vorstehende knöcherne Kinnladen. Keine oder doch unmerkbare schuppen.
      Diodon, Tetradon [Tetraodon], Mola.
   C. Vorstehende Kinnlade. Schüppen (p. 38).
      Soarus. Gehört zur 4ten Abtheilung.
   D. Keine vorstehende Kinnladen. Unmerkbare Schuppen.
      Ammadytes [Ammodytes].
   E. Nicht hervorstehende Kinnladen. Deutliche Schuppen.
      "Muraena (Salmo Linn.) Cyprinus." [Sic!]

Enough has been given to show the erroneous and worthless character of the author's views. The new genera, however, demand further attention. The punctuation, or want of it, is reproduced from the original.

NEW GENERA.

1. Mustelus. "Stumpfe Zähne ein rundlicher Körper M. laevis (Squalus Mustelus Linn.) Unterscheiden sich von dem vorigen Geschlecht [*Squalus*] doch sehr dadurch, dass sie weniger gefrässig sind, sich mehr von vegetabilien nähren, und eine mehr glatte Haut haben."

The name is thus accompanied by a good diagnosis and typonym and consequently is well entitled to place instead of *Mustelus* of Cuvier or *Galeus* of Rafinesque. The genus *Mustelus*, as understood by Jordan and typified by "*Mustelus canis*," is thus bereft of a name and may take that of Cynias.

2. PRISTIS. "Das Maul ist in eine Säge vergezogen," etc.

Squalus pristis is specified as the representative of the genus. The genus is thus well defined, has a typonym, and the name, being long anterior to Shaw's, must be accredited to Linck.

3. RHINOBATOS. "Stumpfe Zähne, Platter Körper."

This name is long prior to *Rhinobatus* of Bloch and Schneider (1801), but is not accompanied by a full definition or a typonym. Happily this is not of much consequence, the names being essentially similar, and different authors may exercise their preference of authorities without difference of result.

4. CALLICHTHYS (Silurus Linn.). The meaning of this association of names is not evident, although the natural inference would be that *Callichthys* was proposed at the expense of *Silurus* of Linnæus. At any rate, it does not militate against the restriction of *Callichthys* to the genus generally known by that name, and was, indeed, probably intended for that genus.

5. COBITIS. This name stands out without any qualification as that of a fish with uniform teeth in both jaws. Linck, consequently, must have intended to restrict the name to *Anableps*, and did remove the *Cobitis barbatula* and *tænia* from the Linnæan genus to constitute a new one (*Barbatula*) on a later page (38). He referred to the "*Cabitis* [*Cobitis*] *heteroclita*" of Linnæus as a fish of uncertain relationship. ("Ungewisse Stellen haben Blennius Cornutus Cabitis heteroclita, Chaetodon Ciliaris, Gasterosteus ovatus" (p. 33).

6. ALOSA.

7. THYMALLUS.

Linck, in a paragraph under section 3, remarks that *Alosa* has no lingual teeth, and that *Thymallus* differs somewhat from *Salmo*, but does not say, in so many words, that they are distinct generically. The paragraph is reproduced from p. 35 to enable anyone to judge for himself.

Das Geschlecht Clupea ist noch nicht genau bestimmt, die meisten haben im Gaumen kleine Zähne. Alosa hat keine Zähne auf der Zunge. Sie sind keine Raubthiere. Thymallus weicht etwas von Salmo ab. Sie hat nur wenig Zähne im Gaumen, und zuweilen ein paar auf der Zunge. Auch ist sie kein Raubfisch.

This seems scarcely sufficient to entitle Linck to recognition as the responsible authority for the generic names.

8. MOLA. "Mola est zu sehr durch die körperform verschieden, als dass das Geschlecht könnte unter Tetradon [Tetraodon] stehen."

Mola is thus sufficiently named and differentiated from *Tetraodon*, but fortunately there need only be a change of authority for the genus—Linck (1790), instead of Cuvier (1798).

9. SOARUS. This name, already referred to (p. 960), is not presented in a form sufficiently precise to require attention or to entitle it to

precedence over any other name. Indeed, it is very uncertain what was intended by the name. It was probably a misprint for *Saurus*. Now there are four well-known fishes with which the name of *saurus* has been associated *Elops saurus*, *Synodus saurus*, *Scomberesox saurus*, and *Trachurus trachurus*. None of these is destitute of teeth, though the *Scomberesox saurus* has extremely small ones, the jaws are much produced, and the lower one is considerably longer than the upper. It is probable, therefore, that Linck had that species in view when he named the genus *Soarus*, but, of course, the name has no right of way over *Scomberesox*.

10. Barbatula. "Hieher gehören Cobitis Barbatula Taenia. Sie nähern sich Cobitis sehr."

This, a synonym of *Cobitis* in a wide sense, is left after the elimination of *Cobitis anableps* and *C. heteroclitus* from the ill-defined Linnæan genus.

Of the nine new generic names proposed by Linck, three are well entitled to adoption from him, *Mustelus*, *Pristis*, and *Mola*. The others do not seem to be presented in such form as to demand recognition; they are *Rhinobatos*, *Callichthys*, *Alosa*, *Thymallus*, *Soarus*, and *Barbatula*.

NOTICE OF A SMALL COLLECTION OF FISHES, INCLUDING A RARE EEL, RECENTLY RECEIVED FROM H. MAXWELL LEFROY, BRIDGETOWN, BARBADOS, WEST INDIES.

By Barton A. Bean,
Assistant Curator, Division of Fishes.

On December 12, 1902, the United States National Museum received from Mr. Lefroy a few fishes, including a small eel, which proves to be the rare *Ahlia egmontis*, heretofore known only from the type described by Dr. David Starr Jordan from a specimen 15 inches long, obtained by him at Egmont Key, Florida.[a]

The example here noticed, No. 50594, U.S.N.M., is 5¾ inches long; its proportions are essentially the same as those given for the type. The color is olive, tinged with yellow, thickly punctulated with darker

Aplia egmontis.

everywhere except a narrow space, from tip of lower jaw to vent, which is silvery. Eye, black. Mr. Lefroy's label for the specimen is "No. 57. White Sand Eel, Barbados."

Since examining the above Dr. H. M. Smith, of the U. S. Fish Commission, has called my attention to one of these eels just received from Dr. J. C. Thompson, U. S. Navy, Dry Tortugas, Florida. It measures 8½ inches. Dr. Thompson gives the following life colors: "Uniform yellowish olive; on head an oblong dull red blotch, and a similar colored streak on opercle, probably the blood showing through at these points; abdomen silvery."

[a] Proc. Nat. Acad. Sci. Phila., 1884, p. 44.

Other specimens received from Mr. Lefroy are:

No. 50593. Striped sand eel (*Echidna catenata*), Barbados, in shallow water. No. 6 of the collector.

No. 50595. Yellow fish (*Chætodon striatus*), Carlisle Bay, Barbados. No. 80.

No. 50596. White fish (*Chætodon ocellatus*), Carlisle Bay, Barbados. No. 83, Oct., 1902.

No. 50597. Black fish (*Pomacanthus zonipectus*, young), Carlisle Bay, Barbados. No. 81.

No. 50598. Coffer or koffer fish (*Lactophrys triqueter*), Carlisle Bay, Barbados. No. 84.

ON SOME FISH GENERA OF THE FIRST EDITION OF CUVIER'S RÈGNE ANIMAL AND OKEN'S NAMES.

By Theodore Gill,
Honorary Associate in Zoology.

In the first edition of the Règne Animal (1817) Cuvier introduced many new genera or subgenera, but most of them were named only in French guise. Consequently many naturalists have refused to accept them, but adopted the first Latin names given subsequently, whether they were simply Latin equivalents for Cuvier's or substitutes for them. My desire to retain the excellent name *Luciopera* for the pike-perches led me to search for earlier commentators on Cuvier and latin equivalents of his names than I had previously found. Several years ago I concluded to look through the volumes of the Isis and ascertain if Oken had anything to say about the subject. The volume for that year in the library of the Smithsonian Institution was without an index, but finally, at page 1145, I came upon an elaborate commentary by Oken[a] on the classification proposed by Cuvier, and that classification and Oken's arranged in parallel columns. I communicated this discovery to several naturalists, and among them to President Jordan, who has consequently been able to "get to bottom" in the case of several of the Cuverian genera. In order that others may have equal facilities, I hereinbelow give the names of Cuvier which were prefixed by a French article and without formal Latin names. Cuvier was quite inconsistent in the latinization of the names, sometimes giving them with all formality, within parentheses, after the French names, but generally neglecting to do so. The names here treated are those respecting which the neglect was manifested.

The volumes of Isis are often quite difficult to consult. In the present case, Oken's commentary extends through the whole of five numbers entitled and numbered as follows:

No. 144, columns 1145–1152; no. 145, columns 1153–1160; no. 146, columns 1161–1168; no. 147, columns 1169–1176. There are two columns to each page and the columns (not pages) are numbered.

[a] Cuviers und Okens Zoologien neben einander gestellt: in Isis, 1817, pp. and col. 1145–1179 + 1779–1782 + 1182–1184 (irregularly numbered: see explanation above).

"Zu 147," two leaves [1177–1178] = four pages.

The only leaf numbered is 1178; there are two columns to each page, as in case of previous numbers.

No. 148, pages [1779–1782].

On these pages there are also two columns, and the matter is continued without interruption from the last page of the previous number. The numbers 1779, 1780, 1781, and 1782 are merely slips for 1179–1182.

"Zu 148," leaves [1183–1184] = four pages.

All these parts are constituents of a number "VIII," which embraces parts 131 to 151. All are without indication of the month or week or other date than "1817."

The section relative to the fishes is in the last three columns of pages numbered "1781" and "1782" and the first three columns of leaf 1183.

Without this explanation the reader would be naturally perplexed.

GENERIC NAMES.

No.	Cuvier.	Oken.	Page or leaf.
129	Les Cestracions Cuv	Cestracion	Leaf 1183
152	Les Monacanthes Cuv	Monacanthus	1183
153	Les Alutères Cuv	Alutera	1183
153	Les Triacanthes Cuv	Triacanthus	1183
165	Les Curimates Cuv	Curimatus	1183
166	Les Piabuques Cuv	Piabucus	1183
184	Les Stomias Cuv	Stomias	1183
185	Les Salanx Cuv	Salanx	1183
193	Les Cirrhines Cuv	Cirrhinus	1183
199	Les Lebias Cuv	Lebia (neu)	1183
202	Les Schilbé Cuv	Schilbe	1183
204	Les Bagre Cuv	Bagre	1183
204	Les Agéneiores Lacep. [sic]		1183
212	Les Morues Cuv	Morr	1183
213	Les Merlans Cuv	Merlongus	1183
214	Les Merluches Cuv	Merluccius	1183
215	Les Lottes Cuv	Lota	1183
215	Les Mustèles Cuv	Mustel	1183
215	Les Brosme Cuv	Brosme	1183
223	o Monochires Cuv	Monochirus	1183
226	Les Lumps Cuv	Lumpus	1183
231	Les Congres Cuv	Conger	1183
235	Les Alabès Cuv	Alabes	1183
239	Les Fierasfers Cuv	Fierasfer	1183
246	Les Vogmares		1183
252	Les Gonnelles		1183
252	Les Opistognates Cuv		1183
262	Les Crénilabres Cuv	Crenilabrus	1183
272	Les Daurades	Aurata	1183
277	o Plectropomes Cuv	Plectropomus	Page 1782
279	Les Pristipomes Cuv	Pristipom	1782
280	Les Diagrammes Cuv	Diagramma	1782
281	o Grammistes Cuv	Grammistes	1782
281	Les Priacanthes Cuv	Priacanthus	1782
283	Les Stellifères Cuv	Stellifer	1782
286	Les Pterois Cuv	Pterois	1782
291	Les Pomatomes	Pomatomus	1782
294	Les Sandres Cuv	Sander	1782
296	Les Cingles Cuv	Zingel	1782
299	Les Otolithes Cuv	Otolithes (Joh. rub.)	1782
299	Les Ancylodons Cuv	Ancylodon (Lonch. A.)	1782
310	Les Chironectes Cuv	Chironectes! (L. Histr.) L	1782
316	Les Vomers Cuv	Vomer	1782
324	Les Atropus Cuv	Atropus (Brama A)	1782
327	Les Voiliers Cuv	Istiophorus	1782
328	Les Leptopodes Cuv	Leptopod	1782
331	o Chelmons	Chelmo	1782
339	Les Anabas Cuv	Anabas (Anthias test)	1781
342	Les Seserinus	Seserinus	1781
344	Les Amphiprions	Amphiprion	1781

Several of these names have undesirable ending, as *Lebia*, *Bagre*, *Brosme*, and *Otolithes*. Others are incomplete, as *Morr.*, *Must.*, *Pristipom.*, and *Leptopod.* Apparently Oken was undecided himself as to appropriate endings, and left them as he has done on account of this uncertainty.

In an article "On the relations and nomenclature of Stizostedion or Lucioperca," published in 1894,[a] I was unable to find a latinized generic name for the pike-perches earlier than 1820, when Rafinesque published the name *Stizostedion*. The name *Sander*, published in the year 1817 as Cuvier's, must now be received and take its place. By those authors, however, who consider the American and European species to be distinct generic types, *Stizostedion* will be retained for the former and *Sander* be taken for the latter.

Zingel must supersede *Cingla* or *Acerina*.

The generic names that may be accepted as dating from this work are *Monacanthus*, *Alutera*, *Triacanthus*, *Curimatus*, *Piabucus*, *Cirrhinus*, *Bagre*, *Lota*, *Brosme*, *Monochirus*, *Aurata* (=*Sparus*), *Plectropomus*, *Priacanthus*, *Stellifer*, *Sander*, *Zingel*, *Otolithes*, and *Chelmo*. When Cuvier gave a Latin or Greek ending to a word, it may be considered as a genuine scientific name even if he did prefix it with a French article or give a French accent.

[a] Proc. U. S. Nat. Mus., XVII, 123–128.

REPORT ON THE FRESH-WATER OSTRACODA OF THE UNITED STATES NATIONAL MUSEUM, INCLUDING A REVISION OF THE SUBFAMILIES AND GENERA OF THE FAMILY CYPRIDIDÆ.

By Richard W. Sharpe,
Instructor in Biology, Wilmette, Illinois.

INTRODUCTION.

The following report presents in part the results of a study of the fresh-water Ostracoda belonging to the United States National Museum. The greater portion of the material was collected from quite widely separated regions. Places as remote from one another as New Jersey and California on the one hand, and Oregon and Mexico on the other, are represented.

The material has been collected by friends of the U. S. National Museum, somewhat cursorily and in small quantities. Dr. E. Palmer, Dr. Alfredo Dugés, Mr. E. W. Berry, and Prof. H. I. Smith, are among those who have contributed.

So much confusion and error has arisen on account of the genus name *Cyprinotus*, that I shall here use it as a subgeneric name under the genus *Cypris*. The attempt has been made to distinguish the genus *Cyprinotus* from the genus *Cypris* by means of the method of propagation and the presence or absence of tubercles on the right shell margin. *Cyprinotus* was distinguished from *Cypris* by being sexual while *Cypris* parthenogenetic—also by possessing a row of tubercles on the right shell margin, which *Cypris* lacked.

As regards the method of propagation, it is undeniably the case that it is not always a genus character among the Ostracoda. For instance, *Ilyocypris gibba* Rahmdohr is not represented by males, while *Ilyocypris lacustris* Kaufmann is propagated sexually.

Indeed, European forms of *Cypris clavata* Baird are parthenogenetic, while African forms of the same species are sexual. Furthermore, *Cypris testudinaria* Sharpe is sexual, a character which might have allied it with *Cyprinotus*, but it is entirely without tubercles on the shell margins. In fact, it seems that this species breaks down any possible barrier between *Cypris* and *Cyprinotus*, indicating that

at most *Cyprinotus* should have but the rank of a division of the genus *Cypris*.

Furthermore, I entirely agree with the observations of Kaufmann where he says:

> Ebenso ist das vorhandsein einer Tuberkel-reihe auf dem Shalenrand ein Gattungsmerkmal von sehr fraglichen Wert, da es eben ein rein äusserliches ist, und was für bedenkliche Folgen eine Berücksichtigung solcher rein äusserlicher Merkmale in der Systematik herbeiführt, haben uns de Diagnosen älterer Autoren zur Genüge gelehrt.

The tubercles also seem to be quite variously present on both right and left valves, and regardless of the method of propagation.

I shall therefore regard the genus *Cyprinotus* as a subgenus of the genus *Cypris*, the genera *Heterocypris* Claus and *Amphicypris* Sars being similarly used and for similar reasons (see key, genus *Cypris*).

All species of *Cypris* that are evidently sexual and have a row of tubercles on the right shell margin should fall in the *Cyprinotus* group. Those seemingly sexual and armed with tubercles on the left valve margin and with "pore canals" should fall under the *Heterocypris* group. Provisionally it seems necessary to establish another subgenus, with *Cypris grandis* Chambers as the type. Insufficient data, however, makes this division a doubtful one. All other forms of *Cypris* not included in the above four subgenera will here be classed in *Cypris* proper.

Of the nine species described in this report, I have been enabled to identify seven with forms already recorded. The remaining two species, as also the genus *Spirocypris*, I regard as new to science. As a whole, the museum collection so far affords an addition of three genera and five species as new to the United States, and of these all but *Chlamydotheca* as new to America, this genus being originally described from Mexico.

I owe thanks to Dr. S. A. Forbes, of the University of Illinois, for loan of literature; to Dr. Richard Rathbun and Mr. Charles T. Simpson, of the U. S. National Museum, for loan of material, and to Dr. A. C. Eycleshimer and Mr. C. C. Adams, of the University of Chicago, for many courtesies extended.

SYSTEMATIC SUMMARY.

The fresh-water Ostracoda of the U. S. National Museum are distributed as indicated in the following summaries. The species comprise nine names, distributed in six genera and four subfamilies, as follows:

Family.	Subfamily.	Genus.	Subgenus.	Species.
Cyprididæ	Cypridinæ	2	1	4
	Herpetocypridinæ	2		3
	Cypridopsinæ	1		1
	Cyclocypridinæ	1		1
Total		6	1	9

It is yet too soon to hazard any remarks regarding geographical distribution in America, as too little is known of the range of individual forms.

The following table will, however, show the relative abundance of the museum forms at the time and place of collection:

SUMMARY OF SPECIES OF FRESH-WATER OSTRACODA OF THE NATIONAL MUSEUM.

1. Family CYPRIDIDÆ.
  - (*a*) Subfamily CYPRIDINÆ.
    - 1. Genus *Cypris*.
      - (*a*) Subgenus *Cypris*.
        - 1. *C. virens*, Guanajuato, Mexico, April (few).
        - 2. *C. pubera* Jurine, Oregon (abundant).
        - 3. *C. pellucida* Sharpe, Guanajuato, Mexico, April (abundant). Big Butte, Idaho, September (abundant).
    - 2. Genus *Spirocypris*, new genus.
      - 4. *S. passaica*, new species (few).
  - (*b*) Subfamily HERPETOCYPRIDINÆ.
    - 3. Genus *Herpetocypris*.
      - 5. *H. reptans* Baird, California, September (abundant).
    - 4. Genus *Chlamydotheca*.
      - 6. *C. mexicana*, new species, Mexico, September (abundant).
      - 7. *C. azteca* Saussure, Texas, October (common).
  - (*c*) Subfamily CYPRIDOPSINÆ.
    - 5. Genus *Potamocypris*.
      - 8. *P. smaragdina* (Vavra), Mexico, April (few).
  - (*d*) Subfamily CYCLOCYPRIDINÆ.
    - 6. Genus *Cypria*.
      - 9. *C. exsculpta* Fischer, Michigan, November (common).

SYNOPTICAL KEY TO THE SUBFAMILIES, GENERA, AND SUBGENERA OF THE FRESH-WATER OSTRACODA, INCLUDED IN THE FAMILY CYPRIDIDÆ.

Family CYPRIDIDÆ.

a Natatory setæ commonly reaching beyond end claws. Second feet usually with three terminal setæ of different lengths, two backwardly directed and the middle one sometimes claw-like. First maxillary process usually armed with 6 strong spines .... Subfamily NOTODROMADINÆ, I.

b Second antennæ 6-segmented in both sexes.

c Second feet normal. Terminal seta of caudal ramus missing. Branchial plate on second maxilla of 2 setæ .... *Notodromas*, 1.

cc Second feet with a claw on end segment. Furca normal, but terminal seta small or missing in female. No branchial plate .... *Newnhamia*, 2.

bb Second antennæ 5-segmented in both sexes. Branchial plate present.

c Two terminal claws of ramus, seta-like. Second foot with a claw-like seta. *Cyprois*, 3.

aa Natatory setæ shortened; no swimmers. Second foot with a beak-shaped end segment and a short claw .... Subfamily HERPETOCYPRIDINÆ, II.

b Furca ending in 3 claws; dorsal seta replaced by a short spine. Males unknown .... *Ilyodromus*, 4.

bb Furca normal.

c Second segment of first foot with 2 setæ on anterior margin. Three spines on first maxillary process, the first one commonly toothed. *Chlamydotheca*, 5.

cc Second segment of first foot normal, but 1 seta. Two spines on first maxillary process.

d Spines of maxillary process plainly toothed.

e Length, 1.8 mm. or more. Two setæ on first segment of first foot. *Herpetocypris*, 6.

ee Length, 1.0 mm. or less. One seta on first segment of first foot. *Microcypris*, 7.

dd Spines of maxillary process not toothed .... *Prionocypris*, 8.

aaa Natatory setæ reaching beyond end claws, or approximately to tips of end claws. Second foot with a beak-like end-segment and a claw. Subfamily Cypridinæ, III.

b Two eyes. Natatory setæ reaching beyond end claws. Shell thick and strong .... *Centrocypris*, 9.

bb No eyes, unless rudimentary.

c Testes, if present, originating in anterior part of shell, and anteriorly in form of concentric circles or half-circles.

d Testes in form of concentric half-circles, anteriorly. Shell small, not more than 0.6 mm or 0.8 mm. in length .... *Cypridella*, 10.

dd Testes in form of concentric circles, anteriorly. Shell more than 0.8 mm. in length.

e Shell tumid and excessively hairy. Furca normal, slender, no more than one-half length of shell .... *Spirocypris*, 11.

ee Shell, as seen from side, narrow, oblong, and smooth. Furca excessively developed, more than one-half length of shell .... *Cypricercus*, 17.

ddd Males unknown. Furca with 2 long terminal setæ in place of the usual claws; also usually a short dorsal one. Ovary spirally wound. *Cypretta*, 12.

cc Testes, if present, not originating in the anterior part of shell, and usually not in circles or half-circles.

d Right shell prominently armed with a dorsal, longitudinal, ridge-like process.

e Dorsal process, with thorn-like projections at both extremities. Testes appearing as 8 concentric half-circles in posterior part of shell. *Strandesia*, 13.

ee Dorsal process, with a thorn-like projection at posterior part only. Furca excessively large .... *Acanthocypris*, 14.

dd Shell comparatively smooth, at least no dorsal ridge-like process present.

e Furcal dorsal seta rudimentary or absent. Males present. *Stenocypris*, 15.

ee Furcal dorsal seta plainly present.

f First foot 4-segmented, third and fourth segments united. Shell unusually broad. Furca and its claws smooth ...... *Eurycypris*, 16.

ff First foot not 4-segmented, usually five. Furca usually normal. Propagation sexual or asexual .... *Cypris*, 18.

g Furca normal.

h Length, 3.00 mm. to 3.50 mm. Sexual..Subgenus *Amphicypris*, 5.

hh Length less than 3 mm.

i Parthenogenetic. Valves with or without tubercles. Subgenus *Cypris*, 1.

ii Sexual. Right valve with marginal tubercles. Subgenus *Cyprinotus*, 2.

iii Sexual. Left valve with marginal tubercles. Subgenus *Heterocypris*, 3.

gg Furca abnormal, "terminal seta missing."(?)

h Sexual. Length, 3.00 mm. or more .... Subgenus *unnamed*, 4.

aaaa Natatory setæ usually long. Second foot usually beak-shaped at tip, with a claw. Furca rudimentary, with a lash-like end bristle.

Subfamily CYPRIDOPSINÆ, IV.

b Furca with no dorsal seta, lamellar and ending in a long bristle.

c Shell irregularly sculptured and roughly tubercled. First foot 4-segmented. End segment of second foot not beak-shaped, but small and conical .... *Oncocypris*, 19.

bb Furca usually with dorsal seta, or at least with 2 end setæ.

c Natatory setæ normal, or at least reaching to middle of terminal claws.

d Shell covered with prominent concentric lines. Second antennæ of sexes different .... *Zonocypris*, 20.

dd Shell plain, at least no concentric lines or bands.

e Shell broad from above, tumid. Branchial plate of from 2 to 5 plumose setæ. Parthenogenetic .... *Cypridopsis*, 21.

ee Shell rather narrow from above. Second antennæ usually 4-segmented. Branchial plate of not more than 2 setæ. Sexual or asexual .... *Potamocypris*, 22.

cc Natatory setæ very rudimentary, not adapted for swimming.

Paracypridopsis, 23.

aaaaa Natatory setæ very long, usually twice as long as distance from their origin to tips of end claws. Second feet with 3 setæ, 1 long, the other 2 rather short and backwardly directed. Furca usually normal.

Subfamily CYCLOCYPRIDINÆ, V.

b Natatory setæ reaching well beyond end-claws.

c Terminal segment of second foot small. Ductus of circlets of spine-like setæ, and a distinct central axis. Fourth segment of second antenna of male with 2 sense organs .... *Cypria*, 24.

d Valves of shell of about same size. Right valve margin not usually crenulate .... Subgenus *Cypria*, 1.

dd Valves of shell of decidedly different sizes. Terminal margins of right shell crenulate .... Subgenus *Physocypria*, 2.

cc Terminal segment of second foot long and narrow, three times as long as broad. Ductus of numerous long filaments; no distinct central axis. Fourth segment of second antenna of male with no sense organ on distal end .... *Cyclocypris*, 25.

bb Natatory setæ reaching but to tips of end-claws or slightly beyond.

c Furca with 2 small dorsal setæ. Shell smooth .... *Pontoparta*, 26.

cc Furca normal. Shell tubercled or furrowed in region of eyes, resembling marine forms or *Limnicythere* .... *Ilyocypris*, 27.

aaaaaa Natatory setæ entire lacking, or little developed. Second antennæ of female 5-segmented; of male mostly 6-segmented, and with 2 sense clubs. Terminal segment of second foot with 3 unlike setæ, 2 of which are backwardly directed .... Subfamily CANDONINÆ, VI.

b Shell not reticulated or honeycombed.

c Natatory setæ of first antenna longer than entire antenna. Penultimate segment of second foot of 2 fused segments; foot therefore 4-segmented. Furca normal .... *Cryptocandona*, 28.

cc Natatory setæ of first antenna shorter than antenna. Second antenna 6-segmented in male and 5-segmented in female.

d Furca normal. Branchial plate of 2 setæ. Eye present, small.

Candona, 29.

dd Furca abnormal.

e Anterior or terminal seta of furca missing. Eye rudimentary, disappearing with age .... *Typhlocypris*, 30.

ee Posterior or dorsal seta missing. Branchial plate of 3 setæ. *Candonopsis*, 31.

bb Shell reticulated, tumid. Small, not more than 0.8 mm. in length. *Paracandona*, 32.

The following text contains a few revised generic descriptions—notably that of the genus Cypris—as also short keys to the known North American species. A few other forms are included for purposes of comparison; these, however, being marked with an asterisk (*).

I. Subfamily NOTODROMADINÆ.

1. NOTODROMAS Lilljeborg, 1853.

Monoculus JURINE, Histoire des Monocles, qui se trouvent aux environs de Genève, 1820.—LILLJEBORG, De Crustaceis ex ordinibus tribus, 1853, p. 94.

Cyprois ZENKER, Monographie der Ostracoden, 1854, p. 80.

Notodromas BRADY and NORMAN, A Monograph of the marine and fresh water Ostracoda, Trans. Royal Dublin Soc., 1889, p. 95.

Shell high, smooth. Natatory setæ reach to tips of terminal claws. Second antennæ six-segmented in both sexes. First maxillary process with six toothed spines. Second foot four-segmented, terminating in three setæ, of which two are directed backward. Branchial plate of two setæ. Furca with the two terminal claws seta-like, terminal seta missing, so that furca seems to end in three setæ. Two eyes, separate. Sexual.

a Female with spine-like projection at lower posterior extremity of shell. Shell smooth, noticeably quadrangular .... *N. monacha* O. F. Müller.

2. NEWHAMIA King, 1855.

Newhamia KING, On Australian Entomos., Proc. Royal Soc. Van Diemans Land, III, 1855.—VAVRA, Die Ostracoden vom Bismarck-Archipel, 1901, p. 179.

Shell roughly granulate or tuberculate on outside. Natatory setæ reaching tips of terminal claws. Second antennæ six-segmented in both sexes, that of female terminating with a simple terminal seta, while that of male terminates with a coarsely toothed spine. Branchial plate missing. Terminal seta of furca is usually present in male, but lacking in female. Two separate eyes. Second foot with three setæ of different lengths, one almost claw-like. Ductus of numerous, thickly arranged, chitinous whorls. Furca normal, but terminal seta occasionally missing in female.

This genus includes but two species at present, *N. patagonica* Vavra (1898) from Patagonia, and *N. fenestra* King, Vavra (1901), from Bismarck Archipelago.

3. CYPROIS Zenker, 1854.

Cyprois ZENKER, Monog. der Ostracoden, Wieg. Archiv. f. Naturg., XX, 1854. Pt. 1, p. 80.—BRADY and NORMAN, A Monog. of the marine and fresh water Ostrac., Trans. Royal Dublin Soc., 1889, p. 96.—DADAY, Die anatomischen Verhältnisse von Cyprois dispar, Termesz. Fus., XVIII, 1895.—KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 258.

Shell somewhat high, compressed, smooth. Second antennæ five-segmented in both sexes. First maxillary process with six strong toothed spines. Branchial plate of six setæ. Second foot ending with a claw and a reflexed seta. Furca with two terminal claws seta-like, therefore an appearance as though four setæ on tip of ramus. No American forms known.

II. Subfamily HERPETOCYPRIDINÆ.

4. ILYODROMUS Sars, 1894.

Erpetocypris BRADY and NORMAN, A Monograph of the marine and fresh water Ostracoda, Trans. Royal Dublin Soc., 1889, p. 84.

Herpetocypris SARS, Oversigt af Norges Crustaceer. Christ., Vid. Selsk. Förhd., No. 1, 1890, p. 60.

Cypris VAVRA, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 82.

Erpetocypris CRONENBERG, Beiträg zur Ostracoden-Fauna der Umgegend von Moscou, Bull. Soc. Imp. d. Moscou, 1894, p. 14.

Ilyodromus SARS, Cont. to knowledge of the f. w. Entomos. of New Zealand, Vid. Selsk. Skr. Math. Natur. Klasse, 1894, p. 41.—KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 298.

Natatory setæ much shortened. Spines of first maxillary process toothed. Caudal ramus ending in three claws, dorsal seta replaced by a short spine. Terminal seta present. Males unknown. No American species known.

5. CHLAMYDOTHECA Saussure, 1858.

Cypris DANA, U. S. Explor. Exped. (Com. Ch. Wilkes), XIII, Crustacea, Pt. 1, 1852.

Chlamydotheca SAUSSURE, Mémoire sur divers crustacés nouveaux des Antilles, et du Mexique, Mém. Soc. Phys. et Nat. Genève, 1858, p. 487.—BRADY, Notes on Entomos. coll. by Mr. A. Haley in Ceylon, Jour. Linn. Soc., XIX, 1885; Notes on f. w. Entomos. from S. Australia, Proc. Zool. Soc. London, 1886.

Pachycypris CLAUS, Beitrage zur Kenntniss der Süsswasser-Ostracoden, Arb. Zool. Inst. Wien, X, 1892, p. 55.

Cypris WIERZEISKI, Süsswasser Crustaceen und Rotatorien, gesammelt in Argentinien, Anz. der Akad. der Wiss. in Krakau, Pt. 5, 1892.—TURNER, Notes on the Cladocera, Copepoda, Ostracoda, and Rotifera of Cincinnati, Bull. Sci. Lab. Denison Univ., VI, 1892.—SARS, Cont. to the knowl. of the f. w. Entomos. of New Zealand, Vid. Selsk. Skr. Math. Natur. Klasse, No. 5, 1894.

Chlamydotheca VAVRA, Süsswasser-Ostracoden der Hamb. Magal. Samml., 1898, p. 16; Hamburg.

Herpetocypris DADAY, Micros. Süsswasserthiere aus Patagonien, Termes. Füs., XXV, 1902, p. 296.

Shell with flange-like projections, both anteriorly and posteriorly. Swimming setæ moderately long. Maxillary process with three strong spines. Second segment of first foot with two setæ on anterior margin. Furca commonly normal, toothed on ventral margin. This genus is at once distinguished by the presence of two setæ on anterior margin of second segment of first foot, instead of one, as in other fresh-water Ostracoda. Genus established by Saussure in 1858, with the peculiar flange-like projections on the shell as the basis of distinction

a Furca about 24 times as long as wide, its dorsal margin faintly toothed for one-half its length; shell broadly oval from above .... *mexicana* Sharpe.

aa Furca about 18 times as long as wide, its dorsal margin faintly ciliate its entire length. Shell wedge shaped anteriorly from above............ *azteca* Saussure.

1. CHLAMYDOTHECA MEXICANA, new species.

Plate LXIV, figs. 1–6.

Length, 2.75 mm.; breadth, 1.60 mm.; height, 1.55 mm.

Color noticeably brownish yellow, two narrow, greenish stripes running from the lower posterior margin diagonally toward the anterior upper margin, passing on either side of the muscle impressions and terminating a short distance beyond them (fig. 1).

Surface of shell comparatively smooth, but with a few very short, sparsely scattered papillæ.

Seen from the side (fig. 1) the shell is highest at the middle and posterior third, sloping abruptly to the posterior lower angle, which is provided with a very noticeable hyaline flange. Seen from above (fig. 2) the shell is widest in the middle, rather broadly oval, evenly rounded posteriorly, and rather acutely pointed anteriorly. The anterior extremity has a very broad, strikingly noticeable flange, fringed with rather long hairs.

Ventral margin nearly straight, except for a sinus at its union with the anterior flange (fig. 1).

Natatory setæ of the second antennæ are very plumose, reaching about to tips of terminal claws. Terminal claws slightly curved, the longest about six times as long as the terminal segment, or seven-fifths as long as the last two segments, the shorter claw two-thirds the length of the longer.

The "sense club" is quite near the base of the segment on which it is located.

The second segment of the first pair of feet is provided with two setæ, a feature characteristic of the genus (fig. 3). Terminal claw stout, nearly smooth, and about seven-ninths as long as the last four segments taken together.

The second foot ends in a beak-shaped segment; the terminal claw very much bent and nearly smooth (fig. 4). The longer seta is about three-fifths the length of the penultimate segment, or twice as long as the terminal claw.

Furca almost straight, about twenty-three times as long as wide and very faintly toothed on dorsal margin for about one-half its length (fig. 5).

Terminal claw straight, rather stout, nearly smooth, and one-half as long as furca. Subterminal claw four-sevenths length of terminal one and straight. Terminal seta very slender, two-thirds length of dorsal one, which is slightly more than one-half as long as subterminal claw. No males seen by me.

Described from several specimens which were sent to the United States National Museum by Dr. E. Palmer from Durango, Mexico. Received by the Museum September 11, 1897. Accession No. 32559.

But one other species has been reported from America, *C. azteca* (Saussure), which differs from the above in the form of the shell, furca, and other minor details. In *C. azteca* the ratio of length to breadth of furca is as 17 to 1, while in *C. mexicana* this ratio is about as 24 to 1; moreover, its entire dorsal margin is faintly ciliate in *C. azteca*, while but about one-half this edge is faintly toothed in *C. mexicana*.

2. CHLAMYDOTHECA AZTECA Saussure.

Plate LXIX, figs. 1–4.

Cypris (*Chlamydotheca*) *azteca* SAUSSURE, Mémoire sur divers crustacés nouveaux des Antilles et du Mexique, Mém. Soc. Phys. et Nat. Genève, 1858, p. 487, pl. VI, figs. 45–54.

Length, 3.30 mm.; height, 2 mm.; width, 1.80 mm.

One of the largest forms of this genus known, uniformly yellowish gray in color, with occasionally a dark patch posteriorly. Shell smooth and glistening to the naked eye, but shown to be quite thickly covered with small papillar elevations by using a one-fourth-inch objective.

Seen from the side (fig. 1) the shell is highest at the posterior one-third, sloping rather abruptly to the posterior lower angle, which is provided with a small hyaline flange.

Seen from above (fig. 3), as in *C. mexicana*, the shell is widest at the posterior one-third, bluntly rounded posteriorly, and wedge-shaped anteriorly. There is a very noticeable hyaline flange, fringed with hair, on the anterior margin. Ventral margin nearly straight, except for a sinus at its union with the anterior flange.

Natatory setæ of the second antennæ plumose, reaching to tips of terminal claws. Terminal claws stout, slightly curved, the longest about six times as long as the terminal segment, or five-fourths that of the last two segments. As in *C. mexicana*, the second segment of the first pair of feet is provided with two setæ at its distal angle—a most prominent generic character.

Second foot not especially different from that of *C. mexicana*. Furca almost straight, from 18 to 20 times as long as wide, and faintly pectinate on almost entire dorsal margin (fig. 4).

Terminal claw nearly straight, rather stout, nearly smooth, and one-half length of furca. Subterminal claw two-thirds length of terminal one and straight. Terminal seta slender, six-fifths length of dorsal one, which is two-thirds as long as subterminal claw. No males found in the material at hand.

Described from eighteen specimens sent to the United States National Museum by Mr. J. D. Mitchell, Victoria, Texas. Collected by Mr. Mitchell from a ditch on a rice farm on the west side of the Guadalupe River, Victoria County, Texas, October, 1902; also pools in the neighborhood of Vera Cruz.[a]

This species differs from *C. mexicana* in size, markings, form of shell as seen from above, and ratio of length of furca to its breadth. *C. azteca* is larger, much more wedge-shaped anteriorly as seen from above, lacks the greenish stripes on shell, and furca stouter and shorter as compared with width.

6. HERPETOCYPRIS Brady and Norman, 1889.

Erpetocypris Brady and Norman, A Monog. of the marine and fresh-water Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 84.

Herpetocypris Sars, Oversigt af Norges Crustaceer, Christ. Vid. Selsk. Forhd., No. 1, 1890, p. 62.—Cronenberg, Beitrag zur Ostracoden–Fauna der Umgegend Moscou, Bull. Soc. Imp. d. Moscou, No. 3, 1894.—Brady and Norman, A Monog. of the marine and fresh-water Ostracoda, Pt. 2, Trans. Royal Dublin Soc., 1896, p. 722.—Kaufmann, Zur Systematik der Cypriden, Mitteil. der Naturf. Gesell. in Bern, 1900, p. 105.

Natatory setæ rudimentary; no swimmers. Spines of first maxillary process plainly toothed. Length, 1.80 mm. or more. First segment of first foot with two setæ. Dorsal seta of furca very small. Sexual or asexual. Three of the following species are reported from America:

a Length about 4.00 mm. Furca about twenty times as long as wide. *barbatus* (Forbes).
aa Length between 2.00 mm. and 3.00 mm.
  b Terminal claw of second foot at least three times as long as terminal segment.
    c Natatory setæ of second antennæ nearly reaching tips of terminal claws. *intermedia** Kaufmann.
    cc Natatory setæ of second antennæ not longer than the fourth segment.
      d Dorsal edge of furca with five combs of coarse teeth. Terminal claw of furca long and slender.......... *reptans* Baird.
      dd Dorsal edge of furca with seven combs of weak setæ. Terminal claw of furca short and stout.......... *brevicaudata** Kaufmann.
  bb Terminal claw of second foot about as long as last segment.
    c Caudal ramus about ten times as long as wide.......... *strigata** O. F. Müller.
    cc Caudal ramus about seventeen times as long as wide... *peregrina** Kaufmann.
aaa Length between 1.00 mm. and 2.00 mm.
  b "Furca with only terminal claws, lacking both terminal and dorsal setæ"? *minnesotensis* (Herrick).

[a] De Saussure, Mém. Soc. Phys. et Nat. Genève, 1858, p. 490.

3. HERPETOCYPRIS REPTANS Baird.

Plate LXV, figs. 1–4.

Cypris reptans LILLJEBORG, De Crustaceis ex Ordinibus tribus, 1853, p. 123, pl. XI, figs. 21–23; pl. XII, figs. 7–9.—BRADY, A Monog. of the recent British Entomos., Trans. Linn. Soc., XXVI, Pt. 2, 1868, p. 370, pl. XXV, figs. 10–14; pl. XXXVI, fig. 4.—VAVRA, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 86, fig. 28.—WIERZEISKI, Süsswasser-Crustaceen und Rotatorien, gesammelt in Argentinien, Anz. der Akad. der Wiss. in Krakau, Pt. 5, 1892, p. 187.—ZACHARIAS, Faunistische Mitteilungen, Forsch. d. biol. Station zu Plön, Pt. 2, VI, 1894, p. 63

Erpetocypris reptans BRADY and NORMAN, A Monog. of the marine and fresh-water Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 84, pl. XIII, fig. 27.—CRONENBERG, Beitrag zur Ostracoden-Fauna der Umgegend von Moscou, Bull. Soc. Imp. d. Moscou, No. 3, 1894, p. 15, pl. VII, fig. 14.—RICHARD, Sur la faune des eaux douces des Açores, Bull. Soc. Zool. de France, XXI, 1896, p. 173.

Herpetocypris reptans SARS, Oversigt af Norges Crustaceer, Christ. Vid. Selsk. Forhd., No. 1, 1890, p. 17.—CLAUS, Beiträge zur Kenntniss der Süsswasser-Ostracoden, Arb. Zool. Inst. Wien, X, 1892, pl. IV, figs. 13–14.—KAUFMANN, Die Ostracoden der Umgebung Berns, Mittlg. d. Naturf. Gesell. in Bern, p. 74, 1892.—HARTWIG, Verzeichniss der lebenden Krebsthiere der Provinz Brandenberg, Statt. handsch. Mittlg., 1893, p. 25; Berlin.—DADAY, Fauna Regni Hungariæ, 1897, p. 6; Budapest.—LIENENKLAUS, Erster Beitrag zur Kenntniss der Ostracoden fauna des Regierungs bezirks Osnabrück, 12 Jahresber. d. naturw. Vereins zu Osnabrück f. d. Jahr. 1897, p. 111.—SCHNEIDER, Die Tierwelt der Nordseeinsel Borkum, Ostracoda, Abhand. Naturw. Verein, XVI, 1898, p. 161; Bremen.—KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 282, pl. XVI, figs. 1–3; pl. XVIII, figs. 21–26.

Dimensions, American: Length, 2.00 mm.; height, 0.80 mm.; breadth, 0.65 mm. European: Length, 2.50 mm.; height, 1.10 mm.; breadth, 0.90 mm.

Shell somewhat brownish yellow, with a darker patch as seen from the side, smooth and glistening, yet rather opaque, and covered with very small papillæ.

Seen from the side the shell is more than twice as long as wide (fig. 1), the upper and lower margins nearly parallel. The lower margin is weakly sinuate. Seen from above (fig. 2) the shell is a narrow oval, rather sharply pointed anteriorly, blunter posteriorly, and widest just back of the middle.

The second antennæ are stout, terminal claws about as long as the penultimate segment. Natatory setæ short, extending about to the base of the terminal segment. The two spines on the first maxillary process are stout and toothed.

Terminal claw of the second foot more than twice as long as the terminal segment and strongly curved (fig. 3). Furca rather stout (fig. 4), about sixteen times as long as wide, broad at base, slightly curved, and the dorsal edge armed with five combs of coarse teeth.

Terminal claw stout, slightly bent, about one-half as long as the furca. Subterminal claw as long as terminal seta, which is slightly more than one half length of terminal claw. Dorsal seta slender, about twice as long as width of furca and situated about one-fourth width of furca from subterminal claw.

This species is characterized by the shape of its shell, long terminal claw of second foot, and the five combs of teeth on the dorsal edge of the furca. While the specimens examined by me were somewhat smaller than the European forms as described by Vavra and Kaufmann, yet they retain the same relative proportions. The European forms of this species vary within quite wide limits, hence the variation of the American form as regards size is not at all surprising.

The specimens studied by me were obtained in part from Ensenada, Lower California, and from Oakland, California, and are now in the collection of the U. S. National Museum. Those from Ensenada were collected by Mr. C. R. Orcutt and received by the Museum October 18, 1889, Accession No. 22456. Those from Oakland were collected by Dr. R. E. C. Stearns, Cat. No. 12221.

This species occurs in England, Scotland, Ireland, Sweden, Norway, France, Germany, Switzerland, Sicily, Lower California, and California.

It has not heretofore been reported from America.

7. MICROCYPRIS Kaufmann, 1900.

Microcypris Kaufmann, Neue Ostrac. aus der Schweiz, Zoöl. Anz., XXIII, 1900, p. 32.

Natatory setæ, very short. Spines of first maxillæ, toothed. First foot with but one seta on its first segment. Small Ostracods, 1.00 mm. or less in length.

Kaufmann has established this genus to receive those forms differing from *Herpetocypris* in number of setæ on basal segment of first foot. I have added the genus character as to size.

No American forms known.

8. PRIONOCYPRIS Brady and Norman, 1896.

Erpetocypris Brady and Norman, A monog. of the marine and fresh-water Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 87.

Prionocypris Brady and Norman, A monog. of the marine and fresh-water Ostracoda, Pt. 2, Trans. Royal Dublin Soc., V, 1896, p. 724.—Kaufmann, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 292.

Natatory setæ, short. Spines of first maxillæ, not toothed. Length, from 0.9 mm. to 1.6 mm.

This genus seems not to be well distinguished from *Herpetocypris*, except by means of the two maxillary spines and smaller size. No American forms known. *Erpetocypris serrata* Brady and Norman, 1889, page 87, used as the type form.

III. Subfamily CYPRIDINÆ.

9. CENTROCYPRIS Vavra, 1895.

Centrocypris VAVRA, Süsswasser-Ostracodon Zanzibars, Beiheft d. Hamb. Wiss. Anstalten, XII, 1895, p. 15.

Two distinct eyes. Shell unusually strong. Natatory setæ reaching well beyond terminal claws. Two last segments of second antennæ with weak seta-like spines. First mandibular process with four plain spines. Third and fourth segments of second feet long and narrow. Propagation, sexual. Ductus thickly covered with closely arranged rows of chitinous spines. No American forms known.

This genus was established by Vavra to receive a very strikingly spinous form from Zanzibar.

10. CYPRIDELLA Vavra, 1895.

Cypridella VAVRA, Süsswass. Ostrac. Zanzibars, Beiheft d. Hamb. Wiss. Anstalten, XII, 1895, p. 7.

Shell short and tumid. Natatory setæ reach to tips of end claws. Furca, normal. Propagation, sexual. The testes originate in the anterior part of the shell and extend to the lower posterior part, intermediately forming three or four concentric half circles. Their anterior origin in circles seems to be a characteristic of but two other genera—*Spirocypris* and *Cypricercus*.

Genus established by Vavra to receive a form found in Zanzibar.

No American forms known.

11. SPIROCYPRIS, new genus.

Shell excessively hairy; plump. Natatory setæ simple, reaching barely beyond the terminal claws. Feet, as in *Cypris*. Caudal rami normal, slender, and not more than one-half length of shell. Propagation sexual. Testes of male originating in anterior half of shell and arranged in form of concentric circles.

This genus is established to receive an excessively hairy Ostracod, having testes arranged in an unusually pronounced concentric whorl in anterior part of shell. It differs from *Cypridella* in form of testes, which in *Cypridella* is in form of four half circles, also in being much larger; from *Cypricercus*, its nearest relative, in shell characters and size of furca.

These three genera are seemingly the only ones so far known characterized by testes originating in circles in anterior part of shell.

a Shell about twice as long as high, excessively hairy. Testes arranged in form of about four concentric circles in anterior part of shell. Furca about one-half as long as shell .... *passaica* Sharpe.

4. SPIROCYPRIS PASSAICA, new species.

Plate LXVI, figs. 1–3.

Length, 1.60 mm.; height, 0.80 mm.; breadth, 0.82 mm.

Color brownish, with dark blue patches laterally, which connect dorsally with a dorsal band; another patch with a greenish tinge anteriorly, and still another in the posterior region. These both connect with the dorsal band (fig. 2) which runs longitudinally on either side of the hinge.

Shell excessively hairy; hairs fully 0.08 mm. long; coarse and backwardly directed.

Seen from the side (fig. 1) the anterior extremity is wider than the posterior, evenly rounded; dorsal margin almost straight, sloping slightly more rapidly posteriorly. Ventral margin slightly sinuate.

Seen from above (fig. 2) the shell is almost a perfect elongate oval, widest just in front of the dorsal transverse dark band, which is midway.

The testes of the male are arranged in the form of concentric circles in the anterior half of the shell (fig. 1), a very noticeable and striking feature.

Natatory setæ simple, reaching slightly beyond the terminal claws.

Terminal claws moderately curved, and as long as the penultimate segment. Sense club long and slender, three-fifths as long as width of segment at its point of attachment. Terminal claw of the first foot moderately curved, faintly toothed; the two terminal setæ about the same length.

Terminal claw of second foot one and one-half times length of terminal segment. Furca slightly S shaped (fig. 3), 23 times as long as wide; dorsal margin very weakly pectinate. Terminal claw nearly straight, faintly toothed, one-half as long as furca. Terminal seta little more than one-half length of terminal claw, which is one and three-eighths times length of subterminal one. Dorsal seta one-half length of terminal one, and width of furca from subterminal claw.

Described from specimens obtained by Mr. E. W. Berry at Passaic, New Jersey, and now in the collection of the National Museum. Received by the museum June 5, 1894. Accession No. 28378.

12. CYPRETTA Vavra, 1895.

Cypretta VAVRA, Süsswasser-Ostrac. Zanzibars, Beiheft d. Hamb. Wiss. Anstalten, XII, 1895.—G. W. MÜLLER, Ostrac. aus Madagas. und Ost-Afrika, Abhand. Senck. Naturf. Ges., XXI, 1898, p. 283.

Shell short and tumid. Natatory setæ reaching beyond end claws. Furca with two long terminal setæ in place of spines, and a short dorsal seta. Usual terminal seta missing. Ovary spirally wound. Males unknown.

Genus established by Vavra to include a very small, plump Ostracod with furcal armature of three terminal setæ, but no spines. But two species are known, *C. tenuicauda* from Zanzibar and *C. costata* from Madagascar and also East Africa.

13. STRANDESIA Stuhlmann, 1889.

Strandesia STUHLMANN, Vorl. Bericht über eine Reise Nach Ost-Afrika, Sitz. K Akad. der Wiss., XXXII, 1889; Berlin.—VAVRA, Süsswasser-Ostrac. Zanzibars, Beiheft d. Hamb. Wiss. Anstalten, XII, 1895, p. 18.

Shell 2 mm. to 3 mm. long. Natatory setæ reaching tips of end claws. Furca very straight, but normal. Propagation sexual. Testes of male in form of concentric half circles in posterior part of shell. Most characteristically, however, the right shell is armed with a dorsal longitudinal ridge-like flange, having thorn like projections at both extremities. Ductus of thickly arranged rows of chitinous spines.

No American forms known.

14. ACANTHOCYPRIS Claus, 1892.

Acanthocypris CLAUS, Beiträge zur Kenntniss der Süsswasser-Ostracoden, Arb. Zool. Inst. Wien, X, 1892, p. 50.

Neocypris SARS, Fresh-water Entomostraca of S. America, Archiv. for Math. og Naturvid., XXIV, No. 1, 1901, p. 29.

Shell with a characteristic dorsal ridge-like process on right valve, which is sharply produced at the posterior extremity. Natatory setæ reaching tips of end claws. Furca extraordinarily large. Parthenogenetic.

This genus was established by Claus to receive a peculiar South American form, having the peculiar dorsal flange. It is worthy of note here that its only relative so characterized (*Strandesia*) is from Zanzibar and East Africa. Other examples indicate a close structural relation between the Ostracoden fauna of Africa and South America—a relationship which is so apparent in other faunal groups of these continents. *Neocypris gladiator* Sars evidently belongs here.

No American forms known.

15. STENOCYPRIS Sars, 1889.

Stenocypris SARS, On some fresh-water Ostracoda raised from dried Australian mud, Christ. Vid. Selsk. Forh., No. 8, 1889, p. 27.—VAVRA, Süsswasser-Ostracoden Zanzibars, Beiheft d. Hamb. Wiss. Anstalten, XII, 1895, p. 10.—VAVRA, Süsswasser-Ostrac. Deutsch-Ost-Afrikas, Tierwelt Ost-Afrika, IV, 1897, p. 14.

Shell usually long and narrow. Natatory setæ reaching tips of end claws. Furca large, somewhat lamelliform, its dorsal edge usually pectinate, dorsal seta rudimentary or absent. Propagation sexual.

This genus was originally described as being parthenogenetic, but the investigations of Vavra (1895), Daday (1892), and Moniez (1891) disprove this.

Vavra retains *Acocypris* as a group of this genus as being nonsexual and a group Stenocypris as being sexual. Kaufmann discards this genus and revises under a new name, *Dolerocypris*, on the ground that *Cypris fasciata* O. F. Müller, of Sars 1890, is deemed *Stenocypris* by him, even though furca has an evident dorsal seta. This seems to me to be an insufficient reason for establishing a new genus. As the shell of this species is long and narrow, it might well be regarded as a transition form between *Cypris* and *Stenocypris*, but still as a *Cypris*, possibly as the type of a new group. The *Cypris fasciata* of Brady and Norman, 1889 (pl. XII, fig. 1) is without the furcal dorsal seta; so evidently a *Stenocypris*.

No American forms known.

16. EURYCYPRIS G. W. Müller, 1898.

Eurycypris G. W. Müller, Ostrac. aus Madagas. and Ost-Afrika, Abhand. Senck. Naturf. Ges., XXI, 1898, p. 263.

Shell extraordinarily broad. Natatory setæ reach tips of end claws. First foot four-segmented from union of third and fourth segments. Furca normal, slender, smooth; claws smooth. Sexual. This genus has been established by Müller (1898), to include those forms of the subfamily Cypridinæ having the third and fourth segments of the first foot united; foot therefore four-segmented, and with excessively broad shells.

No American forms known.

17. CYPRICERCUS Sars, 1895.

Cypricercus Sars, On some S. African Entomos. raised from dried mud, Christ. Vid. Selsk. Skr. Math. Naturw. Klasse, No. 8, 1895, p. 37.

Shell as in *Cypris*, smooth, narrow, oblong, as seen from the side. Natatory setæ reaching tips of end claws. Feet as in *Cypris*. Furca excessively developed, toothed on dorsal margin, and longer than half-length of shell.

Sexual, the spermatic ducts of male forming a dense coil in the anterior part of each valve. This genus was established by Sars, to receive those forms resembling *Cypris* in most respects, except that the furca is unusually well developed and spermatic ducts as above.

No American forms known.

18. CYPRIS O. F. Müller, 1792.

Cypris O. F. Müller, Entomos. seu Insecta testacea, etc., 1792.—Brady, A Monog. of the recent British Entomostraca, Trans. Linn. Soc., XXVI, 1868, Pt. 2, p. 360.

Cyprinotus Brady, Notes on Entomos. coll. by Mr. Haley in Ceylon, Jour. Linn. Soc., XIX, 1885, p. 301.

Heterocypris Claus, Beiträge zur Kenntniss der Süsswasser-Ostracoden, Arb. Zool. Inst. Wien, X, 1892, p. 7.

Stenocypris G. W. Müller, Zool. Anz., No. 653, 1901.

Amphicypris Sars, Fresh-water Entomos. of South America, Archiv. for Math. og Naturvid., XXIV, No. 1, 1901, p. 16.

Neocypris Sars, Fresh-water Entomos. of South America, Archiv. for Math. og Naturvid., XXIV, No. 1, 1901, p. 29.

Natatory setæ reaching to tips of terminal claws or somewhat beyond.

Second antennæ five-segmented in both male and female. Branchial plate of six plumose setæ. Terminal segment of second foot beak-shaped, with a toothed hook-shaped claw. Furca normal, with two claws and two setæ.

Propagation sexual or asexual. Ductus, when present, of numerous chitinous spines thickly crowded over entire surface of cylinder and usually not in wreaths. I have tentatively divided this genus into the five following groups, for reasons given in the introduction (p. 959; see Key, p. 971).

1. Subgenus CYPRIS.

a Length between 1 mm. and 2 mm.
 b Both spines on first process of first maxilla smooth.
  c Terminal claw of second foot as long as terminal segment.
   d Caudal ramus straight; subterminal claw two-thirds as long as the terminal. Shell four-ninths as high as long........................*clavata* * Baird.
   dd Caudal ramus weakly S-shaped.
    e Subterminal claw of furca half as long as the terminal. Shell two-thirds as high as long..*virens* Jurine.
    ee Subterminal claw of furca nearly as long as terminal. Shell one-half as high as long....................................*altissimus* Chambers.
  cc Terminal claw of second foot twice as long as terminal segment. Terminal claw of furca nearly as long as entire furca...............*ornata* * O. F. Müller.
 bb Both spines on first process of first maxilla toothed.
  c Shell not reticulated with broken lines.
   d Shell less than twice as long as high. Terminal claw of furca half as long as furca.
    e Subterminal claw of furca three-fourths as long as terminal, both smooth, *pellucida* Sharpe.
    ee Subterminal claw two-thirds as long as the terminal ....*fuscata* (Jurine).
   dd Shell more than twice as long as high. Terminal claw of furca one-third as long as furca. Subterminal claw two-thirds as long as terminal. *fischeri* * Lilljeborg.
  cc Shell reticulated. Terminal claw of furca about three-fifths as long as ramus. Terminal seta not more than one-fourth as long as terminal claw. *reticulata* Zaddach.
aa Length between 2 mm. and 3 mm. Third and fourth segments of first foot fused. Shell spinous..*pubera* O. F. Müller.
aaa Length 3 mm. or more.
 b Both spines of maxillary process smooth. Dorsal margin of shell strongly convex, marked with dark bands..............................*herricki* Turner.
 bb Both spines of maxillary process toothed. Dorsal margin of shell nearly straight, marked with dark bands........................*perelegans* Herrick.

5. CYPRIS VIRENS (Jurine).

Plate LXVI, figs. 4–6.

Monoculus virens JURINE, Histoire des Monocles, qui se trouvent aux environs de Genève, 1820, p. 174, pl. XVIII, figs. 15–16.

Cypris pilosa ZADDACH, Synopseos Crustaceorum Prussicorum Prodromus, 1844, p. 36.

Cypris tristriata BAIRD, The Nat. Hist. of the British Entomos., Ray Society, 1850, p. 152, pl. XVIII, figs. 1–3.

Cypris ornata FISCHER, Abhand. über das Genus Cypris und dessen bei Petersburg vorkommende Arten, Mém. des savants étrangers des sciences de St. Pétersbourg, VII, 1851, p. 157, pl. IX, figs. 7–10.

Cypris pubera FRIC and NEKUT, Korysi země ceské, Prag. Zeits. Ziva, v. J., 1868, p. 46, fig. 26.

Cypris ventricosa BRADY and ROBERTSON, The Ostracoda and Foraminifera of Tidal Rivers, Ann. and Mag. Nat. Hist., VI, 1870, p. 12, pl. IV, figs. 1–3.

Cypris helena MONIEZ, Liste des Copépodes, Ostracodes, etc., recueillis à Lille en 1886, Bull. Soc. Zool. de France, 1887, p. 2.

Cypris virens ZADDACH, Synopseos Crustaceorum Prussicorum Prodromus, 1844, p. 35.—LILLJEBORG, De Crustaceis ex ordinibus tribus, 1853, p. 117, pl. VIII, fig. 16; pl. IX, figs. 4–5; pls. X, XII, and XIX.—BRADY, A Monog. of the recent British Entomos., Trans. Linn. Soc., XXVI, Pt. 2, 1868, p. 364, pls. XXIII, XXXVI, fig. 1.—ROBERTSON, Fauna of Scotland, with special reference to Clydesdale and the western districts, Proc. Nat. Hist. Soc. Glasgow, IV, 1880, p. 14.—HERRICK, Cont. to the Fauna of the Gulf of Mexico and the South, Mem. of Denison Sci. Assc., I, 1887, p. 22.—BRADY and NORMAN, A Monog. of the marine and fresh water Ostracoda, Sec. I, Trans. Royal Dublin Society, 1889, p. 75.—VAVRA, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 102, figs. 3–5; fig. 36.—TURNER, Fresh-water Ostracoda of the U. S., Report State Zoologist of Minnesota, 1895, p. 321, pl. LXXIV, figs. 3–3e.—SARS, On a new Ostracoda, *Stenocypris chevreuxi* SARS, with notes on other Entomos. raised from dried mud, Archiv. f. Math. Natur. Christiana, 1896, p. 24.

Length, 1.69 mm.; height, 0.95 mm.; breadth, 0.90 mm.

Seen from the side (fig. 4) the shell is highest just back of the eyespot, the height being much more than one-half the length. The upper edge is "humped" just back of the eyespot. Anterior and posterior extremities nearly similar, rounded, the posterior dorsal margin sloping more gradually than the anterior. Shell covered with short hairs.

Seen from above (fig. 5) the shell is rather broadly egg-shaped, narrowed anteriorly, the greater breadth being less than the height of the shell. The anterior extremity is tipped with bluish-black, the entire dorsal side is the same color, while in the region of the eyes are two decidedly yellowish areas which extend diagonally downward and anteriorly for about one-half width of shell. Margins of shell with "pore-canals."

The natatory setæ of the second antennæ reach to the end of the terminal claws. The spines on the first maxillary process are toothed,

a peculiarity which may constitute this form a variety, as Vavra speaks of the European forms as having plain spines on this process.

The terminal claw of the second foot is about one and one-half times length of terminal segment.

Furca very weakly S-shaped (fig. 6), about twenty times as long as wide, dorsal margin smooth. Terminal claw weak, smooth, nearly straight, four-sevenths as long as ramus. Terminal seta weak, about twice as long as width of ramus. Subterminal claw about one-half length of terminal one, straight, smooth. Dorsal seta about length of terminal one, weak.

The specimens studied by me seem to be somewhat smaller than the European form of this species as described by Vavra, but agree in most other respects. The furca are of somewhat different proportions; the European form with width to length about as 1 to 12, while the American form exhibits a proportion of about 1 to 18.

The anterior diagonal light patches are very well marked in this species—so much so that even when examined with a hand lens they attract immediate attention.

The specimens examined by me were collected by Dr. Alfredo Dugés (French Consular Agent) at Guanajuato, Mexico, April, 1901, and sent to the U. S. National Museum.

Distribution world-wide.

6. CYPRIS PUBERA O. F. Müller.

Plate LXVII, figs. 1–6.

Monoculus ovatus Jurine, Histoire des Monocles, etc., 1820, p. 170, pl. xvii, figs. 5–6; Genève.

Cypris stricta Zaddach, Synopseos Crustaceorum Prussicorum Prodromus, 1844, p. 32.

Cypris cuneata Baird, The Nat. Hist. of the British Entomos., Ray Soc., 1850, p. 256, pl. xviii, figs. 22–24.

Cypris punctillata Brady, A Monog. of the Recent British Entomos., Ray Society, 1850, p. 365, pl. xxvi, figs. 1–7; pl. xxxxi, fig. 11.

Cypris pubera O. F. Müller, Entomostraca, 1785, p. 56, pl. v, figs. 1–5.—Zaddach, Synopseos Crustaceorum Prussicorum Prodromus, 1844, p. 34.—Fischer, Abhand. über das Genus Cypris, etc., Mém. des Savants étrangers des sciences de St. Pétersbourg, VII, 1851, p. 154, pl. viii, figs. 1–8.—Zenker, Monographie der Ostracoden, Wieg. Archiv. f. Naturg., XX Jahrg., 1, 1854, p. 70.—Brady and Norman, A Monog. of the marine and freshwater Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 74.—Vavra, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 90, figs. 2, 4, 30.

Length, 2.10 mm.; height, 1.25 mm.; breadth, 1.20 mm.

This species is of a greenish color, with a darker patch at its highest and central part, as seen from the side. A light yellowish band extends diagonally backward from about the center of the shell. Shell very sparsely hairy.

Seen from the side (fig. 1) the shell is highest in its anterior one-third, the highest point being decidedly of a hump-like appearance. The anterior end is more evenly rounded than the posterior, wider, and is armed on the outer lip of both valves with a row of from 9 to 11 semitransparent tubercles. The posterior outer margin of the right shell (fig. 2) is armed with two spine-like tubercles, both being at the lower angle near one another and of approximately the same size. The European form of this species seems to be larger, and the two posterior spine-like tubercles vary in size.

Seen from above the shell is broadly egg-shaped, widest just back of the middle, narrowed anteriorly and bluntly rounded posteriorly. The spines of the first maxillary process are toothed. The natatory setæ of the second antennæ (fig. 3) reach about to the tips of the terminal claws and are plumose.

The terminal segment of the first foot is armed with a long, strong claw and two setæ, the outer one of which is not more than one-half the length of the inner, which is about one-third the length of the claw. Third and fourth segments of the first foot fused, so that the foot is four-segmented (fig. 4).

The claw on the terminal segment of the second foot (fig. 5) is very weak, about as long as the segment, the accompanying seta very slender and about three times as long as the claw. Furca nearly straight, twenty-four times as long as wide, dorsal margin smooth (fig. 6). Terminal claw nearly straight, faintly toothed near tip, and three-fifths as long as furca; subterminal claws three-fifths as long as terminal one, smooth. Terminal seta weak, twice as long as width of furca.

Dorsal seta twice as long as the terminal one, and situated one and one-half times width of furca from subterminal claw.

This species may be at once distinguished by the presence of the tubercles and spines on the shell and the fusion of the third and fourth segments of the first foot (fig. 4).

This description is from specimens sent to the U. S. National Museum by Mr. Bailey, from Oregon. (Date unknown to me.)

It has not heretofore been reported from America.

Distribution world-wide.

7. CYPRIS PELLUCIDA Sharpe.

Plate LXVIII, figs. 1-5.

Cyprinotus pellucida SHARPE, Cont. to a knowl. of the N. Amer. f. w. ostrac. incl. in the Fam. Cytheridæ and Cyprididæ, Bull. Ill. State Lab. N. Hist., IV, 1897, p. 434, pl. XLII, figs. 1-6.

Average length, 1.20 mm.; height, 0.75 mm.; breadth, 0.60 mm.

Color a clear, uniform yellowish brown, with no especial marking.

[a] This name would seem to be preoccupied by *C. pellucida* Koch. However, this proves to be a synonym for *Candona lucens* Baird.

Shell almost smooth, with the exception of a few small scattered papillar elevations and anterior and posterior margins with a fringe of sparsely scattered long hairs.

Seen from above (fig. 2) the shell is quite a uniform elongate oval, anterior end narrowed somewhat, posterior end rounded, broadest in the middle.

Seen from the side (fig. 1) the shell is highest about the middle, ventral margin nearly straight, with a slight sinuosity at the middle. The right valve of shell is slightly smaller that the left, its anterior margins armed with a row of about twenty-five tuberculiform teeth (fig. 3). The margin of the left valve has a rather wide hyaline flange and a row of scattered tubercles along the inner margin (fig. 4).

Spines of the first maxillary process are toothed. Natatory setæ of the first antennæ are plumose and reach well beyond the terminal claws.

Terminal claws three and one-half times as long as the terminal segment. Sense club large, about five-sixths as long as width of segment at its point of attachment.

Furca rather stout, slightly bent, about twice as long as terminal claw. Shorter claw about three-fourths as long as the longer. Dorsal seta width of furca from subterminal claw, bent, somewhat plumose, and as long as subterminal claw; terminal seta three-fifths as long as dorsal one.

Collected by Dr. E. Palmer from a trough fed by a spring flowing from a butte near Big Butte Station, Idaho, in September, 1893, and now in the collection of the U. S. National Museum (Accession No. 27409); also collected at Guanajuato, Mexico, by Dr. Alfredo Dugés, April, 1901, and sent to the U. S. National Museum.

Quincy, Illinois, 1882, Havana, Illinois, 1895, and Urbana, Illinois, 1895.

This species was originally described as *Cyprinotus pellucida*, based largely on the marginal rows of tubercles on the valves, the manner of propagation being uncertain, although the material on hand contained no males. The additional material now on hand contains no males, and it is therefore listed under the subgenus Cypris, in accordance with the preceding synopsis.

2. Subgenus CYPRINOTUS.

a Dorsal seta of furca more than one-half length of subterminal claw.
  b Dorsal seta at least twice width of furca from subterminal claw. Terminal claw of second foot strongly curved .... *incongruens* Ramdohr.
aa Dorsal seta of furca not more than one-half length of subterminal claw.
  b Dorsal seta width of furca from subterminal claw.
    c Shell yellowish-brown, marked with bluish-black longitudinal stripes on dorsum and sides, hairy .... *burlingtonensis* Turner.
    cc Shell dirty brown, leathery in consistency, no markings.. *[illegible]* Sharpe.
  bb Dorsal seta twice width of furca from subterminal claw. Color yellowish-green, shell marked with contorted lines, most noticeably on cephalic portion of valves .... *crena* Turner.

3. Subgenus HETEROCYPRIS.

No American forms known.

4. Subgenus, unnamed.

a Length, 3.69 mm; height, 2.09 mm. Color, livid white .... *grandis* Chambers.

5. Subgenus AMPHICYPRIS.

No American forms known.

IV. Subfamily CYPRIDOPSINÆ.

19. ONCOCYPRIS G. W. Müller, 1898.

Oncocypris G. W. Müller, Ostrac. aus Madagas. und Ost-Afrika, Abhand. Senck. Naturf. Ges., XXI, 1898, p. 286.

Shell irregularly roughened, with numerous prominent tubercles. Second antennæ four-segmented in both sexes. First foot four-segmented. Ductus of about eighteen rows of chitinous spines, in sack. Terminal segment of second foot not beak-shaped, but small and conical. Furca with no dorsal seta, lamellar and ending in a long bristle.

This genus was established by Müller to receive a form collected near Majunga, Madagascar.

No American forms known.

20. ZONOCYPRIS G. W. Müller, 1898.

Zonocypris G. W. Müller, Ostrac. aus Madagas. und Ost-Afrika, Abhand. Senck. Naturf. Ges., XXI, 1898, p. 284.

Shell covered with a prominent series of concentric zones. Second antennæ of sexes different. Furca usually with no dorsal seta, lamellar and ending in a long bristle.

This genus was established to receive two forms from Madagascar. *Cypridopsis costata*, a form from East Africa, evidently belongs here. Vavra describes it as having a furcal dorsal seta, a feature not mentioned by Müller. This might, then, constitute the type of a group of the genus.

No American forms reported.

21. CYPRIDOPSIS Brady, 1868.

Monoculus Jurine, Histoire des Monocles qui se trouvent aux environs de Genève, 1820.

Pionocypris Brady and Norman, A. Monog. of the marine and freshwater Ostracoda, Sec. II, Trans. Royal Dublin Soc., 1896, p. 725.

Cypridopsis Brady, A Monog. of the recent British Entomos., Trans. Linn. Soc. XXVI, Pt. 2.—Brady and Norman, A Monog. of the marine and freshwater Ostracodæ, Sec. I. Trans. Royal Dublin Soc., 1889.—Vavra, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 8.—Kaufmann, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, p. 304.

Shell very plump. Natatory setæ extending much beyond the terminal claws. Branchial plate of two to five plumose setæ. Second foot five-segmented, with a strong claw at its extremity. Furca flagelliform, with a small dorsal cilium, or at least two terminal setæ. Males unknown.

Those *Cypridopsis*-like forms with a compressed dorsal aspect, branchial plate of not more than two setæ, and sexual or asexual propagation, I shall include under the genus *Potamocypris*.

a Three transverse dark bands on dorsal and lateral aspect of shell; very plump; common... *vidua* (O. F. Müller).

22. POTAMOCYPRIS Brady, 1870.

Monoculus JURINE, Histoire des Monocles qui se trouvent aux environs de Genève, 1820.

Cypridopsis BRADY, A Monog. of the recent British Entomos., Trans. Linn. Soc. XXVI, Pt. 2.

Candonella CLAUS, Beiträge zur Kenntniss der Süsswasser-Ostracoden, Arb. Zool. Inst. Wien, X, 1892.—VAVRA, Süsswasser-Ostrac. Deutsch-Ost-Afrikas, Tierwelt Ost-Afrika, IV, Berlin, 1897, p. 12.

Cypridopsis VAVRA, Monog. der Ostracoden Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 73.—SHARPE, Cont. to a Knowl. of the N. American freshwater Ostracoda, incl. in the Fam. Cytheridæ and Cyprididæ, Bull. Ill. State Lab. Nat. Hist., IV, 1897, p. 468.

Cypridopsella KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 131.

Potamocypris BRADY, Notes on Entomos. from Northumberland and Durham District, Nat. Hist. Trans. Northumb. and Durham, III, 1870.—BRADY and NORMAN, A Monog. of the marine and freshwater Ostracoda, Sec. I, Trans. Royal Dublin Society, 1889, p. 92.—DADAY, Mikros. Süsswasserthiere aus Patagonia gesammelt von Dr. Filippo Sylvestri im Jahre, 1899 und 1900, Termesz. Füs., XXV, 1902, p. 291.

Natatory setæ about as long or somewhat longer than end claws. Second antennæ usually four-segmented, armature of male coarser than that of female.

Shell narrow from above, rather smooth. Branchial plate of not more than two setæ. Furca rudimentary, with a small dorsal cilium and ending in a long slender bristle. Propagation, sexual or asexual. Ductus of male of about fourteen spiral rows of chitinous spines.

This genus was first established by Brady to include those Cypridopsis-like forms having rather short natatory setæ, four-segmented antennæ, compressed shell, and sexual propagation. To prevent confusion, it seems necessary to add the additional characters, as above.

I consider *Candonella* and therefore *Cypridopsella* as synonymous with the above.

a Furca cylindrical, turgid at base, suddenly narrowing to a bristle, which is little longer than the basal part........................ *newtoni* (Brady and Robertson).
aa Furca broad, gradually narrowing to a bristle. Shell much compressed.

b Natatory setæ of second antennæ reaching to tips of terminal claws. Shell pale green .... *villosa** (Jurine).

bb Natatory setæ of second antennæ reaching beyond tips of terminal claws. Shell grass-green, at least dorsally .... *smaragdina* (Vavra).

8. POTAMOCYPRIS SMARAGDINA (Vavra).

Plate LXV, figs. 5–7.

Cypridopsis smaragdina Vavra, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 80, fig. 26, 1–3.—Sharpe, Cont. to a Knowl. of the N. American freshwater Ostracoda incl. in the fam. Cytheridæ and Cyprididæ, Bull. Ill. State Lab. Nat. Hist., IV, 1897, p. 470, pl. xlvii, figs. 11–12.

Candonella smaragdina Vavra, Süsswasser-Ostracoden der Hamb. Magal. Sammel, 1898, p. 12; Hamburg.

Length, 0.65 mm.; height, 0.45 mm.; breadth, 0.34 mm.

I here give the description as given in my paper of 1897:

This striking and interesting form appears at first glance, if seen from the side (fig. 6), to be in the shape of a half moon, except that the ventral margin is nearly straight. The shell is light to grass green, especially on its dorsal aspect; alcoholic specimens, however, commonly show but a trace of this coloration. Surface thickly covered with long hairs, which are all parallel to one another, backwardly directed and closely appressed to the shell (fig. 6).

The eye-spot, instead of being at the highest part of the shell, as in the typical forms described by Vavra, is slightly below and anterior to this location. Natatory setæ of the second antennæ, long, reaching beyond the tips of the terminal claws by the length of the claws, thus differing from *C. villosa* (Jurine), its nearest relative, the natatory setæ of which reach but to the end of the terminal claws.

Furca rudimentary (fig. 7), the basal part cylindrical, more than three times as long as wide, then suddenly narrowing into a long flagellum, which is fully twice as long as the basal part. The furca also has a dorsal seta at the termination of the basal part, which is slightly longer than the width of the ramus.

At the time the above description was written, I was not sufficiently familiar with the genus *Potamocypris* to rank this form as belonging to it. Further study causes me to believe that this genus is a logical one, and that this form belongs here.

The specimens in the U. S. National Museum were collected in April, 1901, by Dr. Alfredo Dugés, French consular agent at Guanajuato, Mexico.

This form occurs in Bohemia (Vavra); South Chicago (Sharpe), and Guanajuato, Mexico.

23. PARACYPRIDOPSIS Kaufmann, 1900.

Cypridopsis Brady and Norman, A Monog. of the marine and freshwater Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 90.

Paracypridopsis Kaufmann, Cypriden and Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 131.

Shell rather narrow from above. Natatory setæ rudimentary, not adapted for swimming. Furca rudimentary, lamellar, with a lash-like end bristle and a small dorsal seta. Branchial plate of two setæ.

This genus has been established by Kaufmann to receive those *Potamocypris*-like forms which have rudimentary natatory setæ.

No American forms known.

V. Subfamily CYCLOCYPRIDINÆ.

24. CYPRIA Zenker, 1854.

Cypris AUCTORUM, 1785–1854.

Monoculus JURINE, Histoire des Monocles qui se trouvent aux environs de Genève, 1820.

Cypria ZENKER, Monog. der Ostracoden, Wieg. Archiv. f. Naturg., XX Jahrg., I, 1854.—BRADY and NORMAN, A Monog. of the marine and fresh-water Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 68.—VAVRA, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Bohmen, VIII, 1891, p. 62.—CRONENBERG, Beitrag zur Ostracoden-Fauna der Umgegend von Moscou, Bull. Soc. Imp. d. Moscou, No. 3, 1894, p. 13.—KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 329.

Shell rather compressed. Second antennæ of male six-segmented, of female five-segmented, two sense organs on end of fourth segment. Natatory setæ excessively long, reaching far beyond tips of terminal claws. Branchial plate of six setæ. Terminal segment of second foot small. Ductus of male of circlets of spine-like setæ, with a distinct central axis and not inclosed in a sack.

Furca normal, stout. Dorsal furcal seta situated about middle of dorsal margin.

Vavra has described a species of this genus as sufficiently characteristic to justify a subgenus *Physocypria*. I here use it in the group sense, as the characters given seem to be of somewhat doubtful worth, if our experience with the old genus *Cyprinotus* is any criterion.

The subgenus *Physocypria* is distinguished by the following characters, one shell higher or larger than the other, and the anterior and posterior margins of the right shell crenulate. Otherwise as Genus *Cypria*. The subgenus *Cypria* includes the remaining *Cypria* forms.

Seven species have been reported from America.

1. Subgenus CYPRIA.

a Terminal short setæ of the second foot approximately equal.
 b Terminal short setæ of second foot about as long as terminal segment.
  c Terminal claw of furca half as long as furca.
   d Shell covered with a close reticulum of longitudinally subparallel lines. Abdomen without processes .... *exsculpta* Fischer.
   dd Shell plain, but with small puncta. Abdomen with two cylindrical processes .... *opthalmica* Jurine.
  cc Terminal claw of furca three-fifths its length or longer.
   d Subterminal claw with well developed comb of teeth near tip. .... *dentifera* Sharpe.
aa Terminal short setæ of second foot evidently unequal.
 b Shell clear to brownish yellow, with a few scattered puncta. Dorsal seta of furca three times width of furca from subterminal claw .... *obesa* Sharpe.
 bb Shell white, shining, smooth, with numerous almost confluent puncta. Length 0.70 mm .... *mons* Chambers.

9. CYPRIA EXSCULPTA (Fischer).

Plate LXVIII, figs. 6–9.

Cypris elegantula Lilljeborg, De Crustaceis ex ordinibus tribus, 1853, p. 206.

Cypris punctata var. striata Zenker, Monog. der Ostracoden, Wieg. Archiv. f. Naturg., XX Jahrg., I, 1854, p. 77, pl. III.

Cypris striolata Brady, A Monog. of the recent British Entomos., Trans. Linn. Soc., XXVI, Pt. 2, 1868, p. 372, pl. XXIV, figs. 6–10.

Cypris exsculpta Fischer, Beitrag zur kenntniss der Ostracoden, Abhdlg. der math. phys. Klasse der k. bayr. Akad. d. Wiss., VII, 1855, p. 18, pl. XIX, figs. 36–38.

Cypria exsculpta Brady and Norman, A Monog. of the marine and freshwater Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 68, pl. XI, figs. 1–4.—Sars, Oversigt af Norges Crustaceer med, etc., Christ. Vid. Selsk. Forhd., No. 1, 1890, pp. 24–25.—Kaufmann, Die Ostracoden der Umgebung Berns, Mittlg. d. naturf. Ges., 1892, p. 2; Bern.—Turner, Freshwater Ostracoda of the United States, Report State Zool. of Minn., 1895, p. 305, pl. LXX, figs. 1–8; pl. LXXII, fig. 3.—Hartwig, Die Krebstiere der Provinz Brandenburg, Naturw. Wochenschrift, XI, 1896, p. 321.—Sharpe, Cont. to a Knowl. of the N. American f. w. Ostrac. incl. in the Fam. Cytheridæ and Cyprididæ, Bull. Ill. State Lab. N. H., IV, 1897, p. 465, pl. XLVII, fig. 4.—Lienenklaus, Erster Beitrag zur Kenntniss der Ostracodenfauna des Regierungs-bezirks Osnabrück, 12 Jahresber. d. naturw. Vereins zu Osnabrück f. d. Jahr 1897, p. 109.—Stenroos, Das Tierleben im Nurmiärvi-See, Helsingfors, 1898, p. 226.—Kaufmann, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 330, pl. XX, figs. 4–6; pl. XXIII, figs. 17–27; pl. XXXI, fig. 24.

Length, 0.60 mm.; height, 0.38 mm.; width, 0.26 mm.

This species is seemingly as widely distributed as the ubiquitous *Cypridopsis vidua*. It may be readily distinguished by means of the mesh work of longitudinally parallel and anastomosing lines, which extend over the entire surface of the shell (fig. 8).

Those in possession of the U. S. National Museum were collected April 12, 1892, at First Sister Lake, Ann Arbor, Michigan, by Prof. H. I. Smith. Received by the Museum, December 13, 1892. Distribution, world wide.

2. Subgenus PHYSOCYPRIA.

a Left shell higher than right. Terminal short setæ of second foot about twice a long as terminal segment .... *pustulosa* Sharpes

aa Left shell longer than right. Terminal short setæ of second foot only about as long as terminal segment .... *inequivalva* Turner

25. CYCLOCYPRIS Brady and Norman, 1889

Cypris Auctorum, 1785–1820.

Monoculus Jurine, Histoire des Monocles qui se trouvent aux environs de Genève, 1820.

Cypria Zenker, Monog. der Ostracoden, Wieg. Archiv. f. Naturg., XX Jahrg., I, 1854.

Cyclocypris Brady and Norman, A Monog. of the marine and fresh-water Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 70.—Vavra, Monog. der Ostrac. Böhmen, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 67.

Shells approximately same height. Second antennæ six-segmented in male, five-segmented in female, no sense organ on distal end of fourth segment.

Natatory setæ very long. Terminal segment of second foot, long and narrow, three times as long as broad. Ductus of numerous long filaments, not on a distinct central axis, but all inclosed in a sack. Penultimate segment of second foot with a coarse seta on dorsal distal angle. Furca as in *Cypria*.

Kaufmann speaks of one of the smaller terminal setæ of the second feet as being bent S-shaped, and uses it as of generic value. Since this is not true of *C. globosa*, at any rate, I have omitted this as a genus character. Three species have been reported from America.

a Anterior edge of furca about twice as long as its terminal claw..*lævis* O. F. Müller.
aa Anterior edge or furca clearly more than twice as long as its terminal claw.
  b Anterior edge of furca about two and one-half times length of terminal claw.
    c The terminal claws of furca strong and much bent..............*forbesi* Sharpe.
    cc Terminal claws of furca slender and not bent.............*modesta* (Herrick).
  bb Anterior edge of furca about three times length of terminal claws. Terminal claws strong, nearly straight, weakly bent near end. Furca toothed on posterior edge, also with comb of teeth on its side..................*globosa** Sars.

26. PONTOPARTA Vavra, 1901.

Pontoparta VAVRA, Die Ostracoden vom Bismarck-Archipel. Prag., 1901, p. 184.

Shell white, smooth. Natatory setæ reaching approximately to tips of terminal claws. Terminal segment of second foot cylindrical, not bill shaped, with two terminal bristles and a long reflexed one. Males unknown. Furca strong, with two end claws, a terminal seta, and two dorsal ones.

This genus has been established by Vavra with *P. rara* as the type, a peculiar form from Bismarck Archipelago.

No American forms known.

27. ILYOCYPRIS Brady and Norman, 1889.

Monoculus JURINE, Histoire des Monocles qui se trouvent aux environs de Genève, 1820.

Ilyocypris BRADY and NORMAN, A Monog. of the marine and fresh-water Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 106.—KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 343.

Shell hard, entire surface usually pitted or tubercled, and furrowed in region of eyes, thus resembling marine forms or *Limnicythere*.

Natatory setæ reaching approximately to tips of terminal claws. Ductus composed of eighteen or twenty spirally wound chitinous setæ, in sack. Second foot five-segmented, its terminal segment cylindrical and with three long setæ of different lengths, all pointing in same general direction as foot. Penultimate segment of second foot with from two to three setæ. Furca strong, usually with combs of cilia on dorsal margin or sides.

This genus, first established by Brady and Norman with *I. gibba* as the type, has been further defined by Vavra (1891) and Kaufmann (1900) until it now numbers about eight species and two varieties, all found in Europe.

VI. Subfamily CANDONINÆ.

28. CRYPTOCANDONA Kaufmann, 1900.

Cryptocandona KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 361.

Shell smooth, somewhat translucent. First antenna weak, its natatory setæ longer than the entire antenna. Branchial plate of three setæ. Penultimate segment of second foot unsegmented, therefore foot four segmented. Terminal segment of second foot with three setæ of different lengths. Furca normal.

This genus has been established by Kaufmann to include *Candona*-like forms, but having very long natatory setæ on the first antennæ and a branchial plate of three setæ. I believe it will ultimately rank as a group of the genus *Candona*, but consider it best here to use it as given by Kaufmann.[a]

No American forms known.

29. CANDONA Baird, 1850.

Cypris O. F. MÜLLER, Entomos. seu Insecta testacea, etc., 1792.

Candona BAIRD, The natural history of the British Entomos., Ray Society, 1850.—VAVRA, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 41.

Shell white, translucent. Natatory setæ of first antennæ shorter than entire antenna. No natatory setæ on second antennæ. Second antennæ of male six-segmented with two special sense organs, of female five-segmented.

Branchial plate of two setæ. Palp of second maxilla of female two-segmented, of male not segmented, and different in shape. Second foot five- or six-segmented, with two unequally long backwardly directed setæ and one forwardly directed seta. Furca normal, strong. Ductus of about seven rows of chitinous spines. Shell of male ordinarily larger and of another form than that of the female. Can not swim, but creep along the bottom, or burrow.

Eight forms are reported for America.

a One of shorter setæ at tip of second foot sharply reflexed .... *reflexa* Sharpe.
aa Setæ at tip of second foot not reflexed.
b Length of shell about 1.50 mm. Shell inequivalve, second foot six-segmented. *crogmani* Turner.
bb Length of shell about 1.25 mm, or less.
c Furca curved.
d Second foot six-segmented.
e Claws of furca stout, terminal one one-third length of ramus. *fabæformis* Fischer.

[a] Kaufmann, Revue Suisse de Zool., VIII, 1900, p. 361.

ee Claws of furca slender, maxillary spines not toothed.
f Color uniform, white to brownish .... *acuminata* Fischer.
ff Color greenish yellow, blotched with brown ...... *delawarensis* Turner.
dd Second foot five-segmented. Length 0.73 mm .... *simpsoni* Sharpe.
cc Furca not curved.
d Both claws of furca S-shaped .... *sigmoides* Sharpe.
dd Both claws of furca not S-shaped, both gently curved. Terminal claw half as long as furca .... *recticauda* Sharpe.

30. TYPHLOCYPRIS Vejdovsky, 1882.

Cypris (*Typhlocypris*) VEJDOVSKY, Thierische Organismen der Brunnenwässer von Prag, 1882, p. 64.

Typhlocypris VAVRA, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 51.

Candona TURNER, Freshwater Ostrac. of the U. S., Rept. State Zool. Minn., 1895, p. 301.

Shell as in *Candona*. Natatory setæ of first antennæ shorter than entire antenna. Natatory setæ of second antennæ lacking, similar to *Candona*. Eyes rudimentary, disappearing with age. Furca abnormal, anterior or terminal seta missing.

This genus was established by Vejdovsky to include forms generally resembling *Candona*, but lacking terminal seta of furca. *Candona peircei* Turner evidently belongs here, judging from his figures.

a Terminal claws of furca of male about same size; with female one claw is about two-thirds length of other. Color greenish yellow with blotches of brown.
(*Candona*) *peircei* (Turner).

31. CANDONOPSIS Vavra, 1891.

Candonopsis VAVRA, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 54; Süsswasser-Ostrac. Deutsch-Ost-Afrikas, Tierwelt Ost-Afrika, IV, 1897, p. 4; Berlin.—SARS, Freshwater Entomos. of Sydney, 1896, p. 62.—VAVRA, Süsswasser-Ostrac. der Hamb. Magal. Sammel., 1898, p. 9; Hamburg.—KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 357.

Shell and second antennæ similar to *Candona*. Mandible with an excessively long palp. Branchial plate of three plumose setæ. Furca slender, usual dorsal seta absent.

This genus was established by Vavra to receive those *Candona*-like forms which lack the usual furcal dorsal seta.

No American forms known.

32. PARACANDONA Hartwig, 1900.

Paracandona HARTWIG, Candona euplectella bildet eine selbständige Gattung, Zool. Anz., XXII, 1900.

Shell tumid, reticulated, pitted as a honeycomb. Appendages as in *Candona*, but small and slender. Small, beautiful forms, not more than 0.80 mm. long.

This genus has been established by Hartwig to include forms, the type of which is *Paracandona* (*Candona*) *euplectella* Robertson.

No American forms known.

Family CYTHERIDÆ.

33. LIMNICYTHERE Brady, 1868.

Cythere BAIRD, The Nat. Hist. of the British Entomos., Ray Society, 1850, p. 163.
Acanthopus VERNET, Acanthopus, un nouveau genre d'Ostracodes, Forel's Matériaux pour servir a l'étude de la faune profonde du Lac Leman, Ser. 4. 1878, p. 506.
Limnocythere DAHL, Die Cytheriden der westlichen Ostsee, Zool. Jahrbucher, III, Abth. f. Systematik, 1888, p. 597.
Limnicythere BRADY, A Monog. of the recent British Entomos., Trans. Linn. Soc., XXVI, Pt. 2, 1868, p. 419.—BRADY and NORMAN, A Monog. of the marine and fresh-water Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 170.—VAVRA, Monog. der Ostrac. Böhmens, Arch. Naturw. Durchforsch. v. Böhmen, VIII, 1891, p. 107.

Shell strong, irregularly tuberculate or spinous, rather thin. First pair of antennæ five-segmented, with short bristles on their outer edge; second pair four-segmented, the "spinning claw" being either two segmented or unsegmented. Branchial plate of the mandible strongly developed (commonly rudimentary in other members of this group). Furca rudimentary, commonly but two short bristles. Males uncommon.

a Terminal segment of first antennæ seven times as long as wide. Furca cylindrical, about three times as long as wide. Terminal claw of second antenna of male smooth .... *reticulata* Sharpe.
aa Terminal segment of first antennæ four or five times as long as wide. Furca lamellar, six to seven times as long as broad, ending in a bristle. Terminal claw of second antenna of male armed with three or four strong teeth. *illinoisensis* Sharpe.

Family DARWINULIDÆ.

34. DARWINULA Brady and Robertson, 1872.

Polycheles BRADY and ROBERTSON, The Ostracoda and Foraminifera of Tidal Rivers, Ann. and Mag. of Nat. Hist., VI, 1870.
Darwinula BRADY and NORMAN, A Monog. of the marine and fresh-water Ostracoda, Sec. I, Trans. Royal Dublin Soc., 1889, p. 121.—KAUFMANN, Cypriden und Darwinuliden der Schweiz, Revue Suisse de Zool., VIII, 1900, p. 393.

Shell, smooth and fragile. Right shell larger than the left. First antennæ shorter than in the Cyprididæ, and armed with stout setæ. Second antennæ four-segmented, with four or five terminal claws, and without "spinning seta" or "sense seta." First maxilla with a large branchial plate. First pair of feet five-segmented, and shorter than the second pair. Furca subconical, small.

a First antennæ six-segmented, the second four-segmented. Antepenultimate segment of second antenna without a conspicuous one-jointed appendage. *stevensoni* Brady and Robertson.
aa First and second antennæ five-segmented. Antepenultimate segment of second antenna with a conspicuous one-jointed appendage, which terminates in one long and one short filament .... *improvisa* Turner.

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EXPLANATION OF PLATES.

Plate LXIV.

Fig. 1. *Chlamydotheca mexicana*, new species, lateral view.
2. *Chlamydotheca mexicana*, new species, dorsal view.
3. *Chlamydotheca mexicana*, new species, first foot.
4. *Chlamydotheca mexicana*, new species, terminal segments of second foot.
5. *Chlamydotheca mexicana*, new species, furca.
6. *Chlamydotheca mexicana*, new species, spines of first maxillary process.

Plate LXV.

Fig. 1. *Herpetocypris reptans* Baird, lateral view.
2. *Herpetocypris reptans* Baird, dorsal view.
3. *Herpetocypris reptans* Baird, terminal segment of second foot.
4. *Herpetocypris reptans* Baird, furca.
5. *Potamocypris* (*Cypridopsis*) *smaragdina* (Vavra), dorsal view.
6. *Potamocypris* (*Cypridopsis*) *smaragdina* (Vavra), lateral view.
7. *Potamocypris* (*Cypridopsis*) *smaragdina* (Vavra), furca.

Plate LXVI.

Fig. 1. *Spirocypris passaica*, new species, lateral view.
2. *Spirocypris passaica*, new species, dorsal view.
3. *Spirocypris passaica*, new species, furca.
4. *Cypris virens* (Jurine), lateral view.
5. *Cypris virens* (Jurine), dorsal view.
6. *Cypris virens* (Jurine), furca.

Plate LXVII.

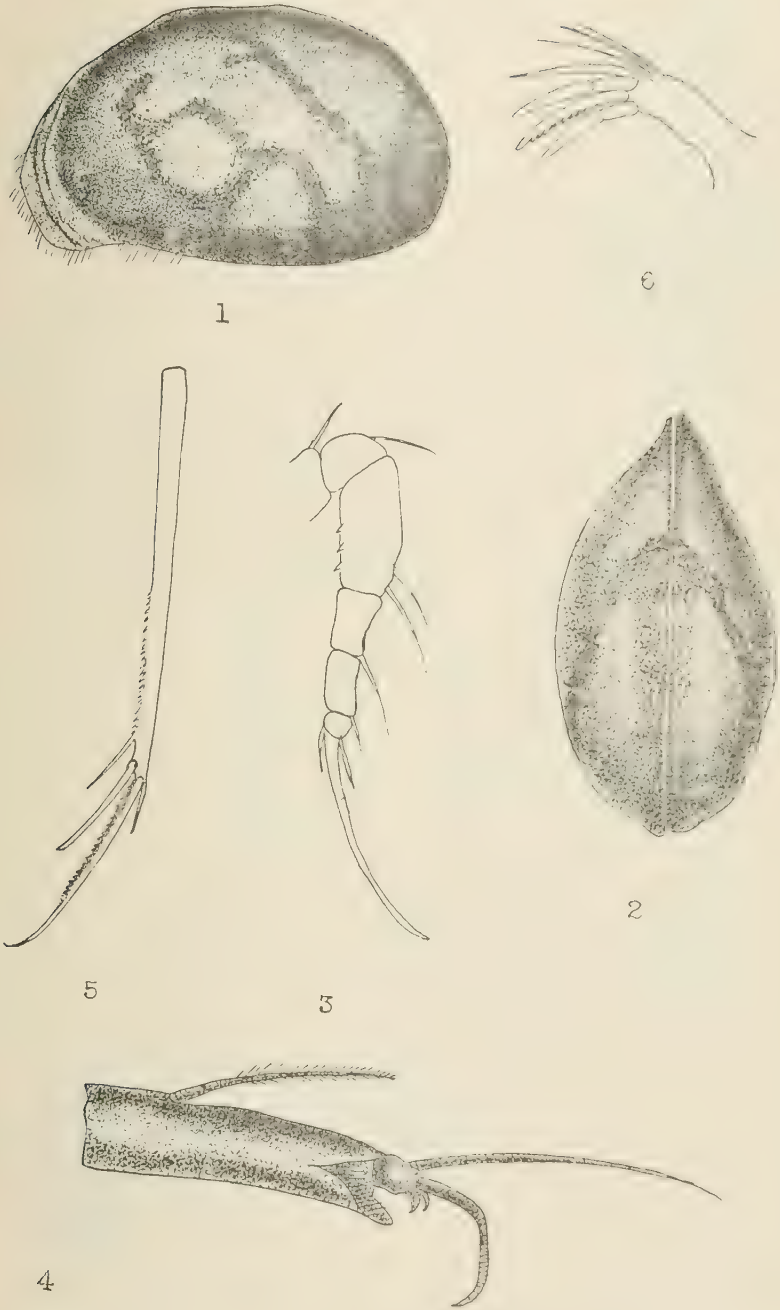
Fig. 1. *Cypris pubera* O. F. Müller, lateral view.
2. *Cypris pubera* O. F. Müller, lower posterior part of right shell.
3. *Cypris pubera* O. F. Müller, third, fourth, and fifth segments of second antenna.
4. *Cypris pubera* O. F. Müller, first foot.
5. *Cypris pubera* O. F. Müller, terminal segments of second foot.
6. *Cypris pubera* O. F. Müller, furca.

Plate LXVIII.

Fig. 1. *Cypris pellucida* Sharpe, lateral view.
2. *Cypris pellucida* Sharpe, dorsal view.
3. *Cypris pellucida* Sharpe, lower outer anterior margin of right shell.
4. *Cypris pellucida* Sharpe, inner anterior margin of left shell.
5. *Cypris pellucida* Sharpe, furca.
6. *Cypria exsculpta* Fischer, lateral view.
7. *Cypria exsculpta* Fischer, dorsal view.
8. *Cypria exsculpta* Fischer, portion of shell showing parallel and anastomosing lines.
9. *Cypria exsculpta* Fischer, furca.

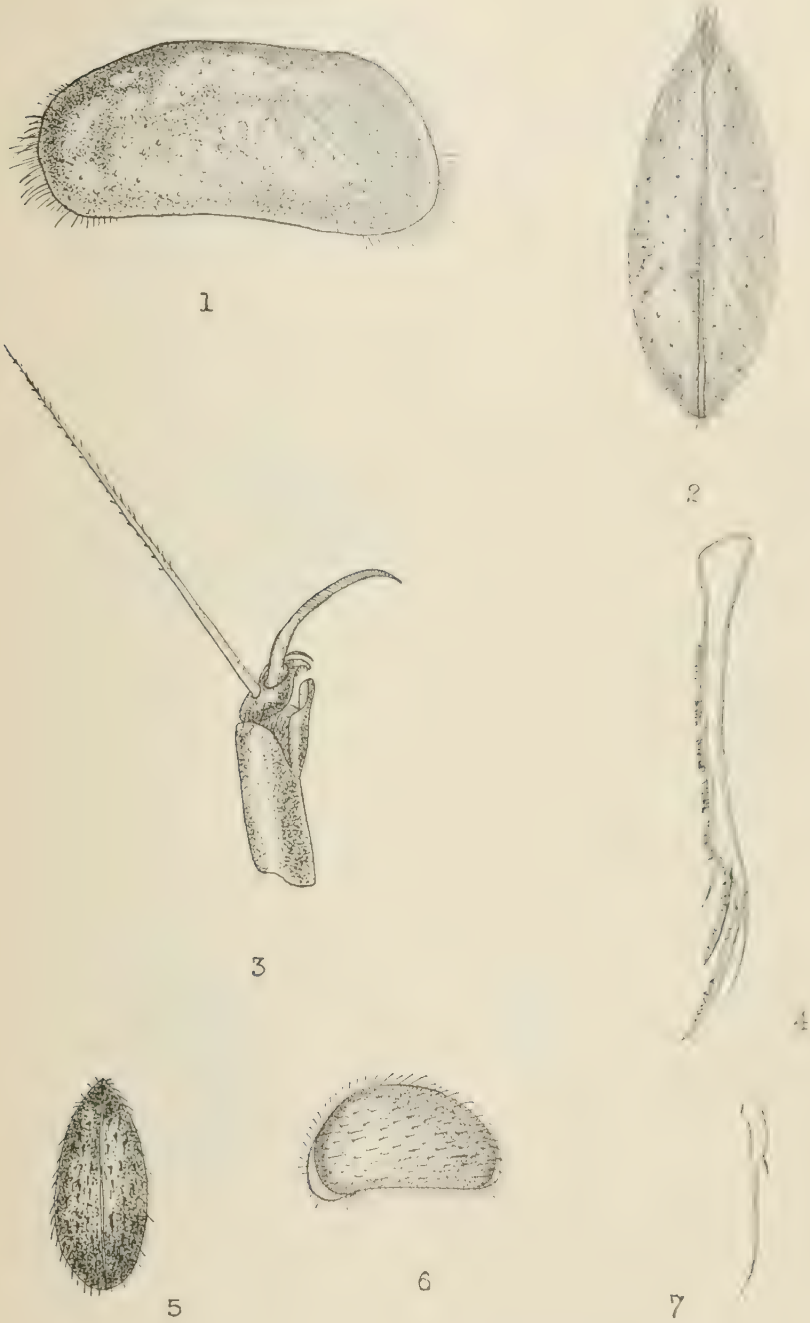
Plate LXIX.

Fig. 1. *Chlamydotheca azteca* Saussure, lateral view.
2. *Chlamydotheca azteca* Saussure, first foot, showing two setæ on its second segment.
3. *Chlamydotheca azteca* Saussure, dorsal view.
4. *Chlamydotheca azteca* Saussure, furca.



CHLAMYDOTHECA MEXICANA, NEW SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 1001.



HERPETOCYPRIS REPTANS AND POTAMOCYPRIS SMARAGDINA.

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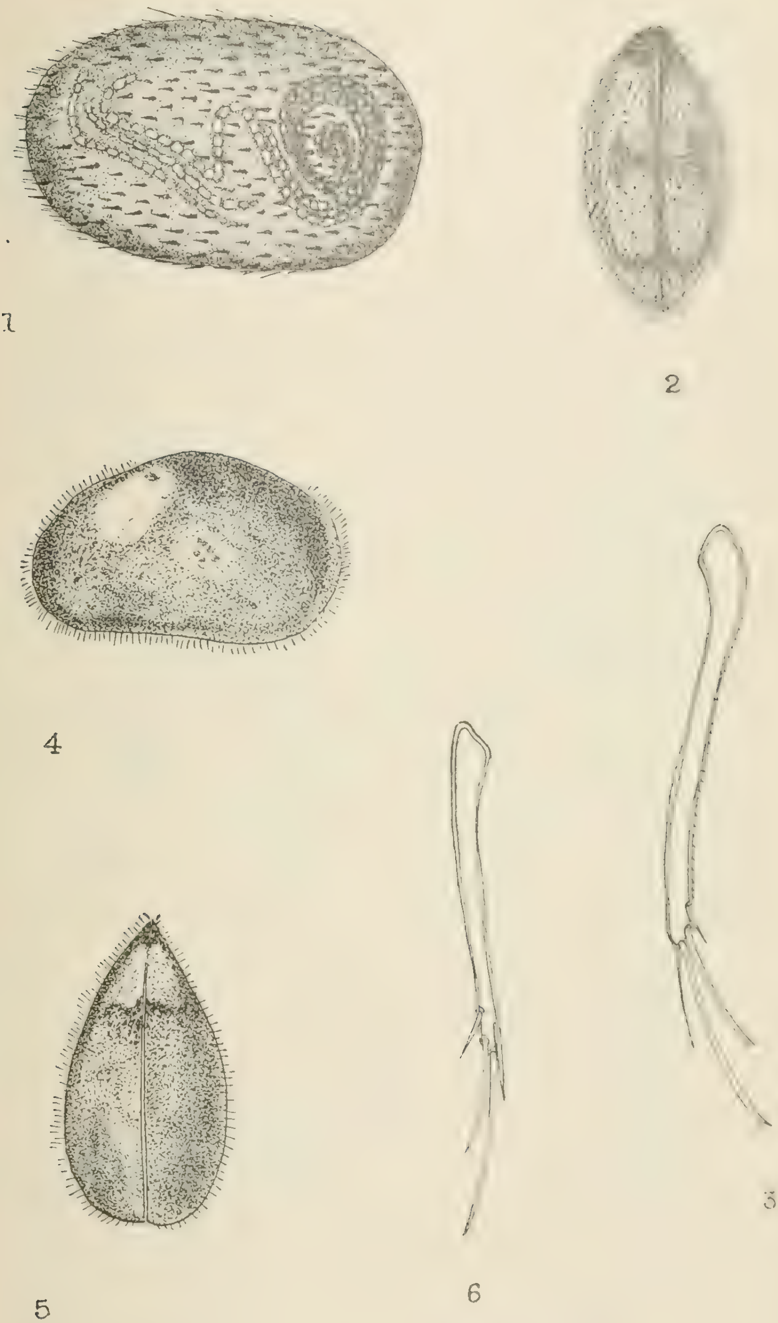

SPIROCYPRIS PASSAICA AND CYPRIS VIRENS.

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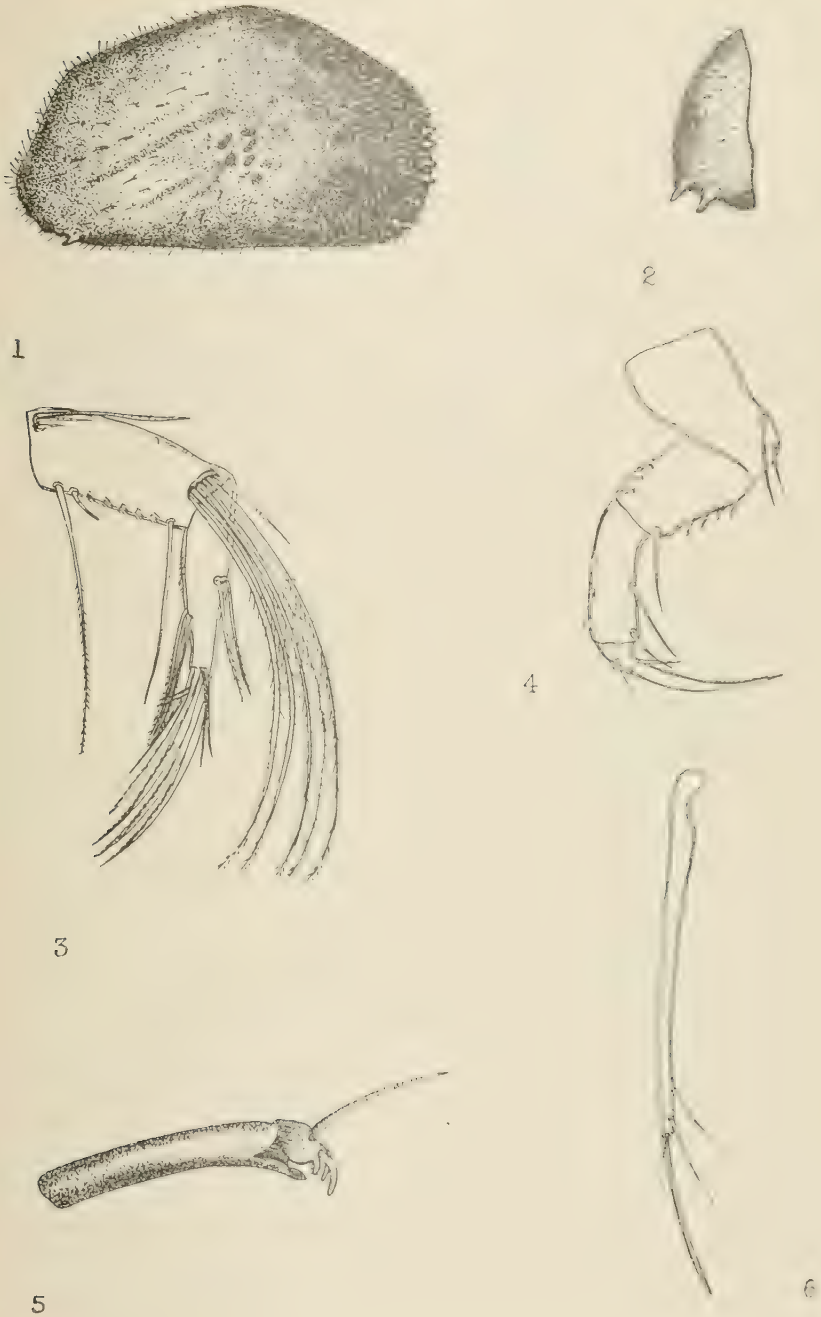

CYPRIS PUBERA.

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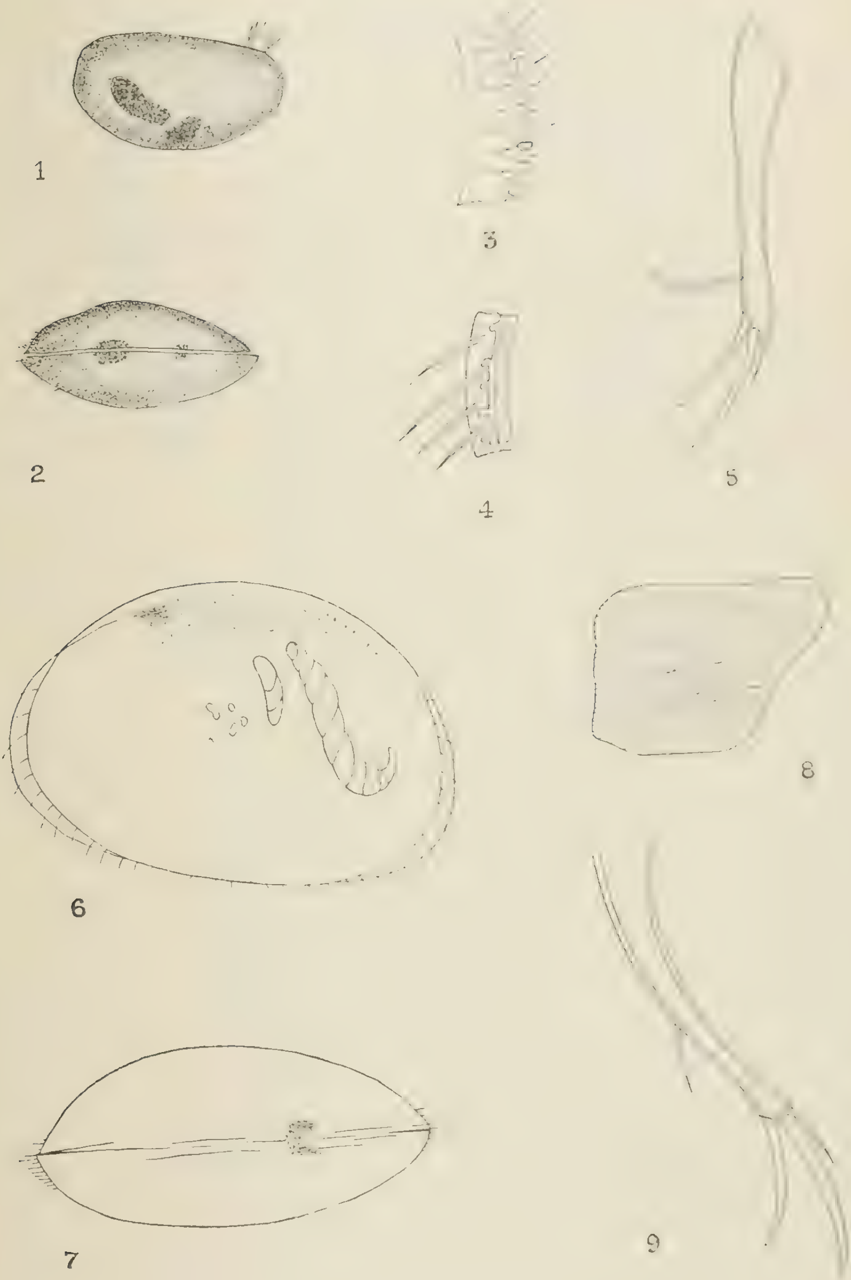

CYPRIS PELLUCIDA AND CYPRIA EXSCULPTA.

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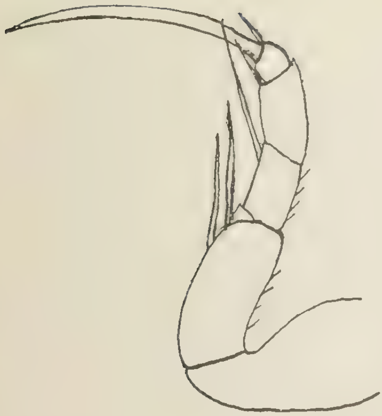
1



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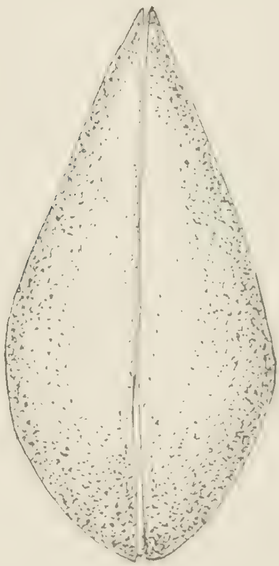

3

4

CHLAMYDOTHECA AZTECA.

FOR EXPLANATION OF PLATE SEE PAGE 1001.

A REVIEW OF THE FISHES OF JAPAN BELONGING TO THE FAMILY OF HEXAGRAMMIDÆ.

By David Starr Jordan and Edwin Chapin Starks.
Of the Leland Stanford Junior University.

In this paper is given a review of the fishes of the family of Hexagrammidæ, Rock Trout or Greenlings, in Japanese Ainame, known to inhabit the waters of the Japanese Empire. It is based on material in the museum of Leland Stanford Junior University and in the United States National Museum.

Family HEXAGRAMMIDÆ.

Body elongate, covered with small scales, which are ctenoid or cycloid; head conical, scaly, the cranium without spinous ridges above; preopercle usually more or less armed, sometimes with entire edges; third suborbital developed as a bony stay articulating with the preopercle; acute teeth in the jaws, and usually on vomer or palatines; nostril single on each side, the posterior opening reduced to a minute pore; gills 4, a long slit behind the fourth; gill membranes separate or united, usually free from the isthmus; branchiostegals 6 or 7; pseudobranchiæ well developed. Dorsal fin continuous or divided, the anterior half of many slender spines; anal fin long, with or without spines; ventrals 1 to 5, inserted more or less behind the pectorals; pectorals broad, usually with procurrent base, the lower rays simple, more or less thickened; lateral line present, sometimes several series of pores developed; vertebræ numerous; pyloric cæca. Carnivorous fishes, mostly of large size, living in kelp and about rocks in the North Pacific; some of them highly valued as food.

a Dorsal fins contiguous or connected.
  b Anal fin very long, its rays 20 or more.
    c Anal fin without spines.
      d Hexagrammınæ: Gill membranes broadly united; mouth moderate, the jaws with an outer series of stronger teeth, but no canines.
        e Lateral line single on each side .... *Agrammus*, 1.
        ee Lateral lines 4 or more on each side.
          f Dorsal fin with the spines separated from the soft rays by a deep notch .... *Hexagrammos*, 2.

1. AGRAMMUS Günther.

Agrammus GÜNTHER, Cat. Fish, 1860, II, p. 94 (*agrammus* = *schlegeli*).

Head and body compressed, rather elongate. Scales small, ctenoid. Lateral line single. Bones of head not armed. Edge of preopercle entire. Dorsal continuous, elongate, with 17 or 18 spines and 21 or 22 soft rays; a shallow notch between spinous and rayed portions. Ventral with 1 spine and 5 soft rays. Teeth small, on jaws and vomer, the outer row of teeth on jaws enlarged; palatines toothless. A flap above orbit and one at nape. Branchiostegals 6.

Japanese fishes, differing from *Hexagrammos* mainly in the undivided lateral line.

(ἀ, without; *γραμμή*, line.)

1. AGRAMMUS AGRAMMUS (Schlegel).

KUJIME.

Labrax agrammus SCHLEGEL, Fauna Japonica, Poiss., 1843,[a] p. 56; Nagasaki.
Agrammus agrammus JORDAN and SNYDER, Check List., 1801, p. 101; Yokohama.
Agrammus schlegeli GÜNTHER, Cat. Fish, II, 1860, p. 94; Japan.—STEINDACHNER and DÖDERLEIN, Fische Japans, IV, 1887, p. 266; Tokyo.—ISHIKAWA, Prel. Cat., 1897, p. 51; Tokyo.

Head 4 in length without caudal; depth $3\frac{1}{2}$. Dorsal XVII or XVIII, 21 or 22; anal 19. Scales 86. Eye 5 in head; maxillary $3\frac{1}{6}$; interorbital 6.

Maxillary reaching just past front of eye. Outer row of teeth enlarged in both jaws; vomer with rather coarse teeth; palatine toothless. A short fringed flap over eye and a shorter similar one at nape.

Pectoral scarcely reaching to tips of ventrals; its posterior edge is broadly rounded; the seventh to tenth rays from the top the longest, $1\frac{1}{10}$ in head. Ventrals reaching two-thirds the distance from their base to front of anal. Notch in dorsal not deep; the fifth spine 2 in head; the last spine $4\frac{1}{4}$; the fourth soft ray equal in length to the fifth spine; the spines or rays not produced beyond the membrane. Tips of anal rays free; the length of the fourth ray equal to the seventeenth ray, $2\frac{2}{3}$ in head. Caudal truncate or very slightly rounded.

Scales strongly ctenoid on body and top of head, slightly rough on side of head behind eye, cycloid on cheek, opercle, breast, and in front of pectoral. Snout, maxillary, mandible, suborbitals, including stay, interopercle and branchiostegal region naked. There are 50 scales in an oblique series running upward and forward from front of anal to dorsal, 18 of these between lateral line and dorsal. Small scales on extreme base of spinous dorsal between spines, and on basal third of soft dorsal; basal third or fourth of pectoral and over half of caudal with scales; anal entirely naked.

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[a] The fourth decade of the Fauna Japonica, Poissons, was published in 1843.

Color in spirits: head and body brown, marbled with irregular spots of dark brown not of the same shape on different examples, but placed with some uniformity; the dark areas darker at edges; a dark bar between eyes followed by a light area; a dark spot at nape united with one at front of dorsal, at its lower edge inclosing a light spot in front of dorsal; a dark spot above pectoral and behind opercle flap; a dark spot under anterior third of dorsal running up on dorsal; one under posterior fourth of spinous dorsal, much broken up and running irregularly across body, sometimes running into the one under anterior third of dorsal inclosing a spot of light color above, a spot under front of dorsal and one under middle, both usually joined below with a larger spot, which is continued down nearly to anal fin; another spot under posterior end of soft dorsal extending up on the fin and margined behind with light; a broken bar across caudal peduncle; caudal crossed with alternate bars of dark and light, the former the broader and about 5 in number; sometimes many of the scales on lower part of sides have white spots on their center; dark bars radiating from eye, one to each end of maxillary, a couple downward and backward across cheek, the upper one being above suborbital stay, one straight backward, and one to nape; lower part of head sometimes with 4 or 5 light spots as large as pupil; anal obliquely crossed by alternate light and dark bars, very conspicuous in the young; these variable in number; the dark bars from 5 to 8; ventrals dusky; a dark spot at base of pectoral; the fin crossed by inconspicuous irregular bars.

Specimens were taken in abundance at Tokyo, Aomori, and Hakodate. It is generally common throughout middle Japan, especially in bays of rocky bottom. It is a common species in the markets, although much less abundant than the "fat greenling," *Hexagrammos otakii*.

2. HEXAGRAMMOS (Steller) Tilesius.

Dodecagrammos STELLER, in Krascheninnikof, Reise in Kamchatka, 1750, p. 175 (*nonbinomial*).

Hexagrammos, STELLER, manuscript.

Hexagrammos TILESIUS, Act. Acad. Petrop., II, 1809, p. 335 (*asper*).

Labrax (Steller MS.) PALLAS, Mém. Acad. Petersb., II, 1810, p. 382 (*lagocephalus*).

Lebius (Steller MS.) PALLAS, Zoographia Rosso-Asiat., III, 1811, p. 279 (*superciliosus*).

Chirus (Steller MS.) PALLAS, Zoographia Rosso-Asiat., III, 1811, p. 279 (*superciliosus*).

Chirus CUVIER, Règne Anim, 2d ed., II, 1829, p. 249 (*superciliosus*).

Chiropsis GIRARD, U. S. Pac. R. R. Surv., X, Fishes, 1858, p. 42 (*c*[illegible]).

Octogrammus BLEEKER, Versl. Ak. Amst., VI, 1874, p. 1370 (*octogrammus*).

Grammatopleurus GILL, Proc. Ac. Nat. Sci. Phil., 1861, p. 166 (*lagocephalus*).

Acantholebius GILL, Proc. Ac. Nat. Sci. Phil., 1861, p. 166 ([illegible] with the soft dorsal injured, the number of spines apparently increased).

Body oblong, somewhat compressed. Head subconical, blunt in profile. Mouth rather small, horizontal; jaws with bands of moderate

sized, conical teeth, the outer row enlarged; teeth on vomer, and usually but not always a small patch on the palatines; preopercle unarmed; a fringed supraorbital cirrus, large or small; gill membranes broadly connected, free from the isthmus; gill-rakers short, tubercle-like. Scales small, mostly ctenoid, sometimes partly or wholly cycloid; head more or less scaly, without spines; nostril simple, round, with a pore behind it. Lateral lines usually 5 on each side. Dorsal fin long, with a deep emargination between the spines and the soft rays; dorsal spines slender, 19 to 22 in number; anal fin elongate, with a single rudimentary spine; rays of pectorals and anal exserted and almost simple; pectoral rounded with broad, procurrent base, the rays thick; ventrals well developed, placed at a considerable distance behind the root of the pectorals; caudal subtruncate. Branchiostegals, 6. Pyloric cæca numerous (about 13.) No air bladder. Species of rather large size and bright coloration; abundant in the North Pacific on both shores, extending southward from Bering Sea.

(ἕξ, six; γραμμή, line.)

a Cheeks not fully scaled, the suborbital stay at least naked; no occipital flaps.
b Fourth lateral line not forked and not extending past tips of ventrals.
c Fifth lateral line joining median line on breast .... *otakii*, 2.
cc Fifth lateral line not joined to median line on breast .... *aburaco*, 3.
bb Fourth lateral line forked in front of ventrals; the upper branch not extending to tips of ventrals; back with obscure dark-bands .... *octogrammus*, 4.
bbb Fourth lateral line running to above middle of anal; elevated about five scales above fifth lateral line; back with dark spots and cloudings ... *lagocephalus*, 5.

2. HEXAGRAMMOS OTAKII Jordan and Starks.

ABURA AINAME (FAT GREENLING).

Labrax hexagrammus Schlegel, Fauna Japonica, Poiss., 1843, p. 53, pl. XXIII, Nagasaki (not of Pallas).

Chirus hexagrammus Bleeker, Verh. Bat. Gen. Japan, about 1867, p. 80.—Ishikawa, Prel. Cat., 897, p. 51; Tokyo, Kii.

Hexagrammus asper Steindachner and Döderlein, Fische Japans, IV, 1887, p. 266; Tokyo (not of Pallas).

Hexagrammos otakii Jordan and Starks, Proc. Calif. Acad. Sci., 1895, p. 800; Tokyo.—Jordan and Gilbert, Rept. Fur Seal Expl., III, 1898, p. 453; Tokyo.—Jordan and Evermann, Fish. N. M. Am., II, 1898, p. 1867; Tokyo.

Head $3\frac{7}{4}$ in length without caudal. Depth $4\frac{1}{4}$ to $4\frac{1}{2}$. Dorsal XIX or XX, 22; anal 21 to 23. Series of scales running downward and backward below third lateral line, 107 to 112. Eye $4\frac{4}{5}$ in head; maxillary $2\frac{4}{5}$ to 3; interorbital space (bone only) $6\frac{1}{2}$.

Maxillary reaching past front of eye scarcely to front of pupil. Outer teeth enlarged and rather uneven on both jaws; palatines toothless; vomer with teeth similar to the smaller teeth on jaws; the band on premaxillaries wider in front than on front of mandible. A short fringed flap above eye, but little longer than diameter of pupil; a pair

of small tentacles on nape. (We have one specimen out of 50 or 60 without tentacles at nape.)

The notch between spines and rays of dorsals not deep; the last spine not longer than the one preceding it; the sixth spine $2\frac{1}{4}$ in head, higher than the longest rays, which are $2\frac{1}{3}$ in head. Pectoral scarcely reaching to tips of ventrals, not nearly to vertical from vent; the sixth ray from the top the longest, $1\frac{1}{3}$ in head; 17 rays, divided toward ends only once. Fifth anal ray 3 in head. Ventrals rather long and pointed, reaching $\frac{3}{5}$ or $\frac{2}{3}$ of distance from their base to front of anal. Caudal concave with fin closed.

Scales everywhere except on head, nape and breast rather strongly ctenoid; 62 scales in a series from front of anal to dorsal in a series running upward and forward, distributed as follows: 5 from front of anal to fifth lateral line; 35 to third; 14 to second; 5 to first; and 3 to dorsal. First lateral line running from front of dorsal or a little before it to a point varying from under anterior third of soft dorsal to posterior fourth. Second lateral line running from a little in front of dorsal to upper part of caudal base; third line from upper end of gill opening to middle of caudal base. Fourth line short, composed of very small pores, running from gill opening, nearly touching pectoral base, to across base of ventral, not reaching to tip of ventral; often it does not extend anteriorly past ventral base. Median line on breast dividing under distal fourth of ventrals and running to lower part of caudal base; these two parts join median line at rather an obtuse angle; when they join it anterior to distal third or fourth of ventrals they form an acute angle; their point of union is never much past middle of ventrals. Scales on top of head to a little in front of eyes. Cheeks closely scaled below suborbitals and preorbital; opercle completely scaled and a few scales on upper part of interopercle. Snout, maxillary, preorbital, suborbitals, including suborbital stay, mandible, the greater part of interopercle and branchiostegals all naked.

Color in spirits light brown, lighter below, marked on back and sides with dark brown quadrate blotches; on back these are arranged as follows: One across interorbital space, one at nape, one under front of dorsal, two equally distributed under spinous dorsal, one under first soft rays, one under middle soft rays, one under last rays, one across caudal peduncle, and traces of one across base of caudal rays; dorsal mottled with dark brown; a darker spot on tips of last spines; pectoral crossed and mottled with bands of dark brown, a dark spot at base of rays; tips of anal rays white, a dark streak bordering fin inside of white border from which 7 or 8 bands cross rays obliquely to base of fin, leaving white intervals between them; many white spots often scattered irregularly over side, and a few larger ones on pectoral; ventrals dusky.

Here described from the 4 typical specimens, the longest 23 cm. in length.

Many specimens were taken by Jordan and Snyder at Tokyo, Aomori, Hiroshima, Nagasaki, Hakodate, Kobe, and Tsuruga. It is abundant throughout Japan, but is not known to the northward of Hakodate. (Named for Keinosuke Otaki.)

3. HEXAGRAMMOS ABURACO Jordan and Starks, new species.

ABURAKO (FAT THING).

Head $3\frac{1}{2}$ in length without caudal; depth $4\frac{1}{4}$. Dorsal XIX, 22; anal 21. Scales below lateral line 110 to 120. Eye $4\frac{3}{4}$ in head; maxillary $2\frac{5}{6}$; interorbital width (bone only) $6\frac{1}{2}$.

Maxillary reaching to front of pupil. Outer teeth enlarged in both jaws; vomer with teeth; palatines toothless. A short flap above eye, fringed at the edge; its length is scarcely equal to diameter of pupil; a pair of very small tentacles at nape.

FIG. 1.—HEXAGRAMMOS ABURACO.

Notch between dorsals shallow, the last spine not longer than the one preceding it; the sixth spine $2\frac{3}{4}$ in head; the last 4. Third dorsal ray 3 in head; tips of last dorsal rays on the same vertical with tips of last anal rays; origin of anal midway between tip of snout and tips of median caudal rays. Pectoral not quite reaching to tips of ventrals; it has 18 rays, their tips not much branched; the seventh ray from the top the longest, $1\frac{2}{3}$ in head. Ventrals reaching five-eighths of distance from their base to front of anal. Caudal concave when fin is closed. In life sometimes bright rusty red with pearly spots; fins rusty red, the lower dusky purplish, the red often replaced by dull green.

Scales everywhere strongly ctenoid, except on head, breast, and in front of pectoral. Top of head to front of eyes, cheeks below and above suborbital stay, and opercle, with fine cycloid scales. Snout, maxillary, preorbital, suborbitals, including suborbital stay, mandible, interopercle, and branchiostegals naked. Scales on base of pectoral

and caudal; and on membrane between soft dorsal rays; other fins scaleless. From front of anal to dorsal in a series running upward and forward there are 67 scales, distributed as follows: 6 scales from first anal ray to fifth lateral line; 41 to third line; 12 to second line; 5 to first line; and 3 to dorsal. First lateral line running from front of spinous dorsal to under middle of soft dorsal; the second from slightly in front of spinous dorsal to upper edge of caudal; the third from upper end of gill opening to middle of caudal; the fourth very short, not extending past ventral tips; the fifth beginning a short distance behind ventral base and running to lower edge of caudal; it does not join its fellow of the opposite side, nor does it join the median line of the breast; the median line starts a short distance in front of ventrals and running between them reaches nearly to their tips.

Color in spirits: Brown on sides and back, becoming lighter below; no definite markings on body; one or two specimens show traces of dark blotches on sides; dorsal irregularly mottled with dusky; anal sometimes obliquely crossed with 7 or 8 dusky bars; sometimes uniformly dark slate color, the tips of the rays white; pectoral with faint, dusky bars following the contour of the posterior edge of the fin; ventrals dusky. In life sometimes bright rusty red with pearly spots; fins rusty red, the lower dusky purplish, the red often replaced by dull green.

This species differs from *Hexagrammos otakii* chiefly in not having the fifth lateral lines connected with each other, nor with the median line on breast.

The type is from Tokyo, and is 225 millimeters in length. One cotype from Nagasaki, and two from Hakodate.

The type is numbered 7374, Ichthyological Collections, Leland Stanford Junior University Museum. Cotypes are in the U. S. Nat. Mus.

(Name from the vernacular, *Aburako:* fat thing.)

4. HEXAGRAMMOS OCTOGRAMMUS (Pallas).

Labrax octogrammus Pallas, Zoogr. Rosso-Asiat., III, 1811, p. 283; Kamchatka, Petropaulski and Avatcha Bay. (Coll. Merk.)

Chirus ordinatus Cope, Proc. Amer. Philos. Soc. Phila., 1873, p. 28; Unalaska. (Coll. Prof. Geo. Davidson.)

Hexagrammus ordinatus Jordan and Gilbert, Synopsis, 1883, p. 642.

Octogrammus pallasi Bleeker, Versl. Ak. Amst., VI, 1874, p. 1370; after Pallas.

Chirus octogrammus Günther, Cat. II, 1860, p. 92.

Hexagrammus octogrammus Jordan and Evermann, Fish. N. M. Am., II, 1898, p. 1869; Unalaska, Petropaulski, Robben, Iturup Island.—Jordan and Gilbert, Rept. U. S. Fur Seal Comm., III, 1898, p. 449, pl. L; same localities.

Head $3\frac{5}{6}$ in length without caudal; depth $3\frac{1}{2}$. Dorsal XIX, 24; anal 25. Scales below lateral line 86 to 95. Eye $5\frac{1}{4}$ in head; maxillary 3; interorbital (bone only) $7\frac{3}{4}$.

Maxillary reaching to below front of pupil. Outer row of teeth enlarged on both jaws; the bands of about equal width on both jaws, much wider in front than on sides; a small patch of teeth on middle of vomer; palatines toothless. A short fringed flap above eye, its length one-half to three-fourths the diameter of eye; no tentacles at nape.

The notch between spinous and soft portions of dorsals of moderate depth; the tips of spines and rays scarcely produced above membrane; the last spine not lengthened beyond the one preceding it; the sixth spine $2\frac{1}{3}$ in head, equal to the tenth or eleventh spine; the sixth ray $2\frac{1}{6}$ in head. Pectorals usually reaching just past tips of ventrals, but not nearly to the vertical from vent; its posterior edge broadly rounded; 19 rays, not much branched; the seventh to the tenth rays the longest, $1\frac{1}{4}$ in head. Anal rays free from membrane at their tips; the fifth ray 3 in head. Ventrals rather long and pointed; their posterior fifth

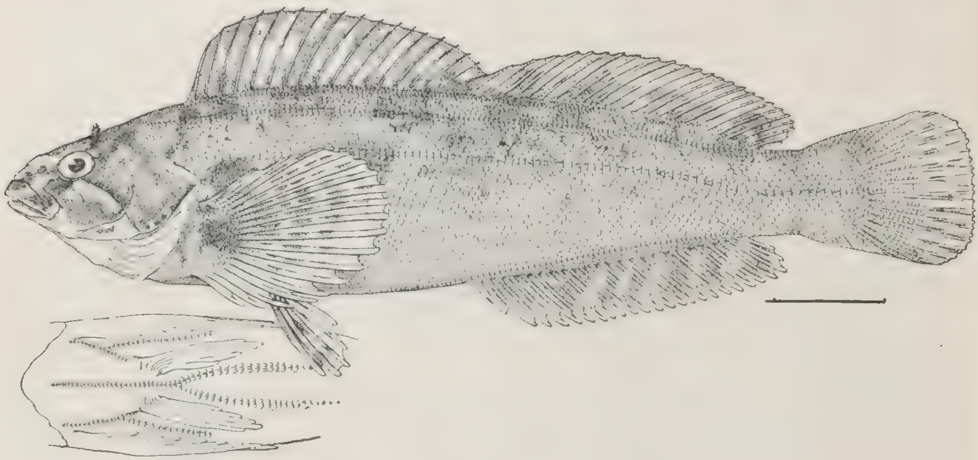

FIG. 2.—HEXAGRAMMOS OCTOGRAMMUS.

extending past the median point between their base and front of anal. Caudal short and broad and very bluntly rounded.

Scales on top of head and on body, except on breast and in front of pectorals, ctenoid; scales on sides of head smooth, slightly imbedded, and not imbricated; scales present at base of soft dorsal, on membrane between rays; and on base of caudal and pectoral, covering the basal half of the former, the basal third of the latter. Snout, maxillary, preorbital, suborbitals, including suborbital stay, mandible, interopercle and branchiostegal regions without scales. A series of scales from front of anal running obliquely upward and forward to dorsal number 47, distributed as follows: 4 from front of anal to fifth lateral line, 28 to third lateral line, 7 to second lateral line, 4 to first lateral line, and 4 to dorsal. First lateral line united to its fellow of the opposite side at posterior end of cranium and running to under middle of soft dorsal; second line beginning a little behind origin of first and running to upper edge of caudal; the third line as usual from upper part of gill opening to middle of caudal; the fourth forked in front of

ventrals, the lower part running to base of ventrals, the upper not reaching to tips of ventrals; the median line on breast forked in front of anterior half of ventrals, and running to lower edge of caudal, or sometimes stopping over posterior end of anal.

Uniform dark brown color on back, lighter below; a dark streak along upper edge of suborbital stay, one from eye to tip of snout, one from eye to end of maxillary, one from eye to nape; these only evident in the small examples; a dark humeral spot; anal uniformly dusky, the tips of the rays white, or in the young crossed by 7 or 8 black bars.

Three large specimens from Hakodate, and numerous small ones from Hakodate and Mororan. This species is abundant from Hokkaido, through the Kurile Islands (Robben Island, Iturup Island) and the Aleutian Islands to Petropaulski and Unalaska.

(ὀκτώ, eight; *γραμμή*, line.)

5. HEXAGRAMMOS LAGOCEPHALUS (Pallas).

Labrax lagocephalus Pallas, Mém. Ac. St. Petersb., II, 1810, p. 384; Kuril Islands.

Grammotopleurus lagocephalus Jordan and Evermann, Check-List Fishes, 1896, p. 435.

Hexagrammus decagrammus Bean and Bean, Proc. U. S. Nat. Mus., 1896, p. 383, specimens from Petropaulski; not of Pallas.

Hexagrammos lagocephalus Jordan and Gilbert, Fishes of Bering Sea, in Rept. U. S. Fur Seal Investigations, 1898, p. 450.—Jordan and Evermann, Fish N. M. Am., II, 1898, p. 1873; Robben I., Bering I., Iturup I.

Head $3\frac{3}{5}$ to 4 in length; depth $3\frac{2}{5}$ to $3\frac{3}{5}$; eye small, about $5\frac{1}{4}$ in head. D. XX to XXIII, 22 to 24; A. 22 to 24; P. 20 to 21. Outer row of teeth enlarged in both upper and lower jaws. Teeth on vomer and front of palatines. Maxillary extending to below middle of eye in adults, $2\frac{1}{3}$ in head ($2\frac{4}{5}$ in young). A small flap above eye, fringed along the margin; no tentacles on nape. Fins high, the spinous dorsal deeply notched, the last spine somewhat longer than the one preceding; in the adult the fifth spine is the longest, nearly $\frac{1}{2}$ length of head, the third and fourth spines nearly equal to the fifth; from the fifth the spines gradually diminish in height to near the end of the fin, when they become rapidly shortened to form the notch. Caudal very broad at base, convex at its posterior margin, even when the fin is closed; pectorals broadly rounded, rather short, the longest rays $1\frac{1}{4}$ to $1\frac{1}{5}$ in head, not nearly reaching vertical from vent; ventral fins 1[illegible] to 2 in head, short and rounded in the young, becoming longer and more pointed in adults; pectoral and ventral rays very broad, especially toward their tips, and much branched; soft rays of dorsal and anal fins cleft on terminal fifth, as in other species, the two halves not diverging; 5 lateral lines on each side as usual, 2 dorsal, a median, and 2 ventral; upper dorsal line continued to beyond middle of second dorsal fin, usually ending under the fourteenth or sixteenth ray; lower

dorsal line and the median line extended to base of caudal; upper ventral line originating below and in front of the pectoral fin, passing immediately above base of ventral, to which it does not send a separate branch, and terminating opposite middle of anal fin; lower ventral line single on breast, forking in advance of middle of ventral fins, the branches passing to base of caudal. In the young the scales are all etenoid, except those in mid-ventral region, breast, prepectoral area, and sides of head all becoming smooth in adult; snout, subocular ring, suborbital stay, interopercle, and usually the lowermost portion of subopercle, scaleless; basal half or more of caudal and basal third of soft dorsal with the membranes densely scaled; pectoral basis also densely scaled; scales on breast not greatly reduced, more than half as large as those on middle of sides; median lateral line with 110 pores; 8 or 9 scales in an oblique series between median line and the one above it. Color in most of our specimens a nearly uniform warm brown, lighter on under parts, marked only with irregular small black

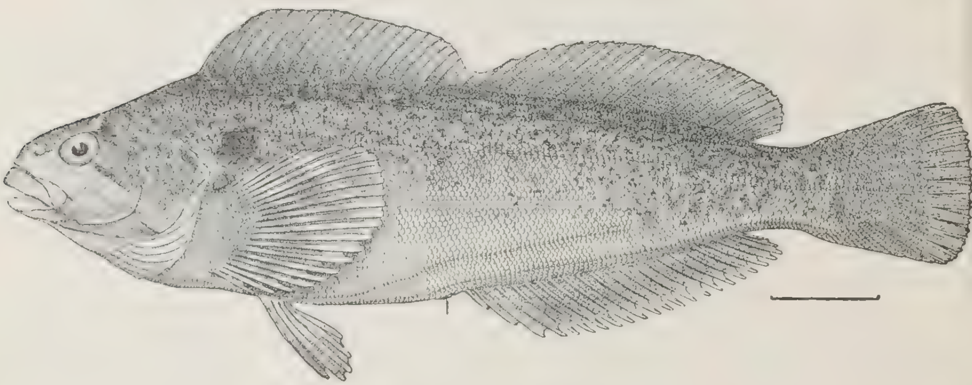

FIG. 3.—HEXAGRAMMOS LAGOCEPHALUS.

spots and lines, which may extend on the dorsal and pectoral fins; anal and ventrals black, the thickened tips of the rays in these and the pectoral fins often white; a large blackish humeral spot in young specimens, often disappearing in adults. One specimen (Iturup Island) has the upper parts, including dorsal and caudal fins, bright reddish, with some dusky blotches and cloudings, the humeral spot conspicuous.

West shore of Bering Sea; not known from Hokkaido nor from Alaska. We have numerous specimens from Robben Island, one specimen each from Bering and Iturup islands. Young specimens up to 20 cm. in length have the scales all rough etenoid as in *H. stelleri* and *H. octogrammus.* Specimens 30 cm. long have most of the scales smooth, a few along middle of sides still etenoid. In an adult 54 cm. long all the scales are smooth, those on head and nape partially imbedded. In shape and general appearance this species very much resembles *H. octogrammus.* It has a deep caudal peduncle, a convexly rounded caudal fin, and a rather bluntly rounded snout.

($\lambda\alpha\gamma\acute{\omega}s$, hare; $\kappa\epsilon\phi\alpha\lambda\acute{\eta}$, head.)

SUMMARY.

Family Hexagrammidæ.

1. *Agrammus* Günther.

1. *agrammus* (Schlegel); Tokyo, Aomori, Hakodate.

2. *Hexagrammos* (Steller) Tilesius.

2. *otakii* Jordan and Starks; Tokyo, Aomori, Hakodate, [illegible], Nagasaki.
3. *aburaco* Jordan and Starks; Tokyo, Nagasaki, Hakodate.
4. *octogrammus* (Pallas); Hakodate, Mororan, Robben I., Iturup I.
5. *lagocephalus* (Pallas); Robben I., Bering I., Iturup I.

Note.—In addition to the species here enumerated, Dr. Peter J. Schmidt records (Faune de la mer du Japon, etc., 1903, p. 15) *Pleurogrammus monopterygius* (Pallas), from near Vladivostok. This should be added to the known fauna of the Japan Sea.

NOTE ON THE FISH GENERA NAMED MACRODON.

By Theodore Gill,

Honorary Associate in Zoology.

Having had occasion recently to consider a question relative to the Sciænids, I found that Drs. Jordan and Evermann had adopted the name *Sagenichthys* of Berg (1895) for the genus called *Ancylodon* by Cuvier (1817). No new name was necessary, however, as one had been given long before as a substitute. The facts should be made known now in order to avoid the continuance of improper usage.

I.

Ancylodon was used by Cuvier (1817) for a genus of Sciænoid fishes and was generally adopted for that genus till 1895. It had, however, been used previously (1811) by Illiger for a genus of Ziphioid cetaceans. This was known to Dr. H. R. Schinz, the translator of the first edition of Cuvier's Règne Animal, and in his work (Das Thierreich) published in 1822 he substituted (II, 482) the name "Die Grosszähne, *Macrodon*," for "*Ancyclodon*, Cuv." or "*Ancylodon*," and in a footnote (II, 483) indicated "Das Wort *Ancylodon*, Hackenzahn, kann deswegen nicht gebraucht werden, weil eine Wallfischart so genannt wird. Es gehört dahin: *Lonchurus ancylodon*, Schneid."

This is in every respect perfectly regular, but the fact has been universally overlooked.

II.

Macrodon was used by Johannes Müller in 1842, in the Archiv für Anatomie, Physiologie [etc.], p. 308, for a genus of the family of Erythrinids (by him associated with his family of Characins) and has been universally retained for it ever since. The previous use of the name by Schinz (in 1822), however, renders it untenable for a later genus, and the one designated by Müller may receive the new name

HOPLIAS, with the *Macrodon tareira* or *trahira* of Müller as its type. The species will therefore be called *Hoplias tareira* by those who object to erroneous names and *Hoplias malabaricus* by those who insist on retaining the first given name, however erroneous it may be.

The name *Hoplias* is derived from the Greek ὅπλον, ὅπλα, armor, with the suffix -ίας and allusion is made to the defensive armature in the way of the cranial shield-like surface as well as the offensive teeth. An analogous classical name is *Xiphias*.

This name *Hoplias* is given with full knowledge of the name *Hoplia* of Illiger. The two names are quite distinct.

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